

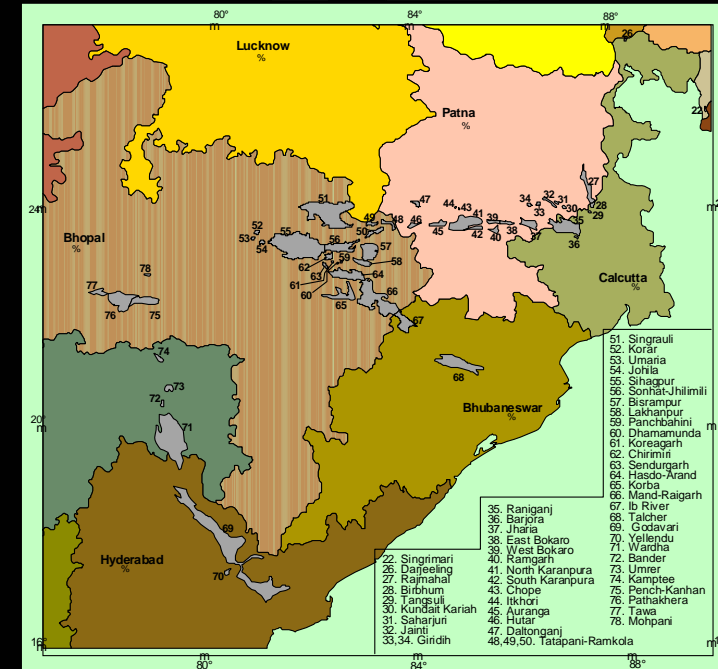
Coal resource position in India

Geological Survey of India

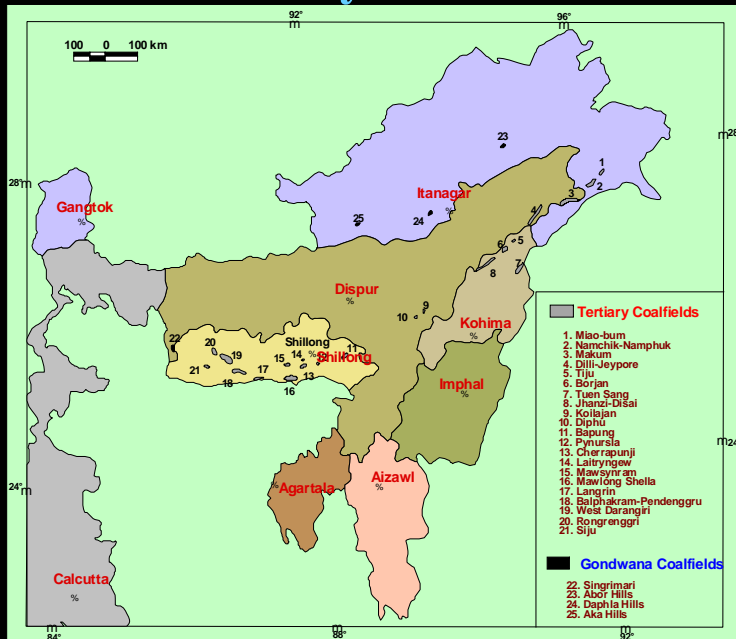
Coal occurs in two stratigraphic horizons

Permian sediments (c. 290Ma) mostly deposited in Intracratonic Gondwana basins.

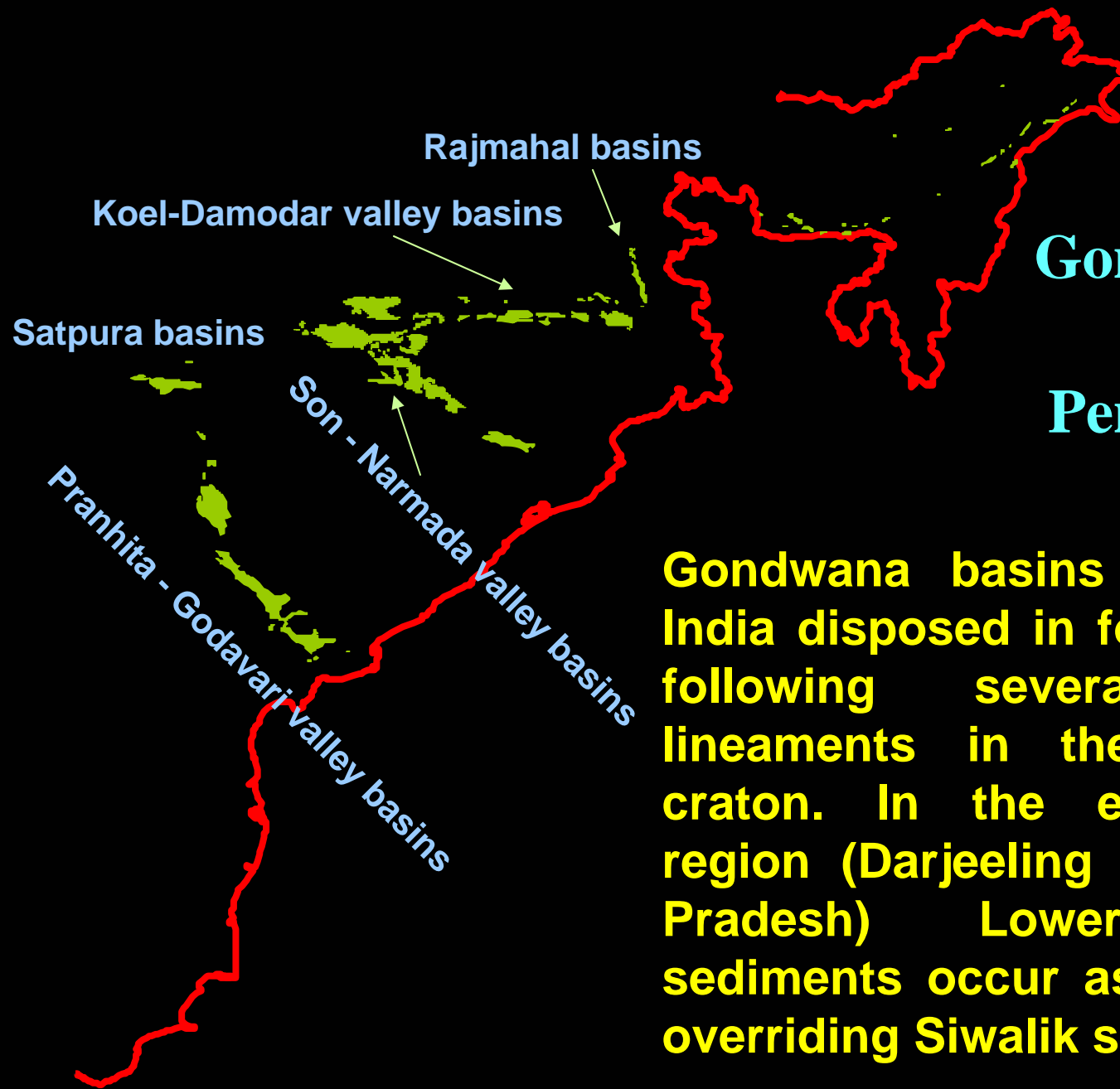
Lower Gondwana coalfields



Tertiary coalfields



Early Tertiary (c. 60Ma) near-shore peri-cratonic basins and shelves.



Gondwana basins of Peninsular India

Gondwana basins of Peninsular India disposed in four linear belts following several prominent lineaments in the Precambrian craton. In the extra-Peninsular region (Darjeeling and Arunachal Pradesh) Lower Gondwana sediments occur as thrust sheets overriding Siwalik sediments.

Gondwana coal

Occurrence	Eastern and central part of Peninsular India
Rank	Bituminous to sub-bituminous
Character	Moderate to High in Ash and Low in Sulphur

Tertiary coal

Occurrence	Northeastern India
Rank	Meta and Ortholignitous
Character	High in Sulphur ; Strongly caking to non-caking

Lignite

Occurrence	Western and southern India
Character	High in Moisture and Volatile Matter

GONDWANA COAL

Coal bearing strata

RANIGANJ/KAMTHI FORMATION (Late Permian)–

ECONOMICALLY EXPLOITABLE IN RANIGANJ, JHARIA
EASTERN PART OF SINGRAULI BASIN AND
GODAVARI

BARAKAR FORMATION (Early Permian)–

MAJOR STOREHOUSE OF COAL IN ALL THE BASINS

KARHARBARI FORMATION (Early Permian)–

RESTRICTED TO FEW COALFIELDS OF EASTERN INDIA

TERTIARY COAL

Coal bearing strata

❑ Oligocene sediments –

❖ **Tikak Parbat Formation in Upper Assam, Nagaland and Arunachal Pradesh**

❑ Eocene sediments –

❖ **Tura Sandstone, Lakadong Sandstone in Garo, Khasi and Jaintia hills of Meghalaya**

❖ **Sylhet Limestone in Mikir hills of Assam**

❖ **Lower Subathu Group in Jammu**

Types of Indian coal

Coking

Prime – Low volatile bituminous coals , Coke type G₇ or better, R_o(mean) = 1.2. Upper Barakar seams in Jharia coalfield.

Medium - Low to high volatile bituminous coals, Coke type F-G₆, R_o(mean) = 1.1-1.4. Lower Barakar & Raniganj seams in Jharia, Barakar seams in Raniganj, Bokaro, parts of Ramgarh, Karanpura, Sohagpur and PENCH- Kanhan coalfields

Semi – High volatile, Coke type D-F, R_o(mean) = 0.7. Lower Raniganj seams in Raniganj, Barakar seams in parts of Ramgarh and Sonhat coalfields

Non-coking

Superior – High volatile bituminous B-C coals.
Mainly in Raniganj seams of Raniganj coalfield

Inferior – High volatile sub-bituminous coals. All coalfields

High Sulphur

Tertiary coalfields of Northeastern Region

General characters of Karharbari coal

Comparatively cleaner than Barakar coals

Low moisture, low ash and low to medium volatile

Generally non-coking except in parts of Giridih and North Karanpura

General characters of Barakar coal

- ❖ **Moisture < 2% to 6%**
- ❖ **Volatile - <18 to 35%**
- ❖ **Carbon - 85 to 90% (on dmf basis)**
- ❖ **Ash - 15 to 30% (excluding dirt bands)**
- ❖ **Coking properties (eastern CFs of
Damodar Valley basins)**
- ❖ **Coke type - D to G₆ or better**

General characters of Raniganj coal

- ❖ **High moisture**
- ❖ **High Volatile**
- ❖ **Coal seams thinner than those of Barakar**
- ❖ **Best developed in Raniganj coalfield**

RESOURCE CLASSIFIED AS

CATEGORY : (Based on degree of confidence)

• *PROVED (>80%)*

THROUGH DETAILED EXPLORATION

• *INDICATED (>50 to 80%)*

THROUGH REGIONAL EXPLORATION

• *INFERRED (<50 %)*

DEPTH : *0-300 m, 300-600 m and 600-1200 m*

GRADE :

Medium Coking : SG-I, SG-II, W-I, W-II, W-III, W-IV

Semi Coking : Grade-I and grade-II

Non Coking : Superior (Gr.A – C) and Power grade (Gr.D-G)

Prevalent Quality classification system

(Department of Coal, Ministry of Energy, 1979)

☒ Non-coking coal from Gondwana coalfields

<u>Grade</u>	<u>Useful Heat Value (k.cal/kg)</u>	<u>Sp.Gr</u>
A	> 6200	1.42
B	5600 - 6200	1.45
C	4940 - 5600	1.50
D	4200 - 4940	1.55
E	3360 - 4200	1.60
F	2400 - 3360	1.68
G	1300 - 2400	1.76

Useful Heat Value = $8900 - 138(A+M)$

(A= Ash%, M = Moisture% at 60% R.H & 40°C Temperature)

Prevalent classification (contd.)

☒ Coking coal

<u>Grade</u>	<u>Ash</u>	<u>Sp.Gr</u>
Steel Grade -I	< 15%	1.42
Steel Grade -II	15% - 18%	1.44
Washery Grade - I	18% - 21%	1.46
Washery Grade - II	21% - 24%	1.50
Washery Grade - III	24% - 28%	1.53
Washery Grade - IV	28% - 35%	1.58

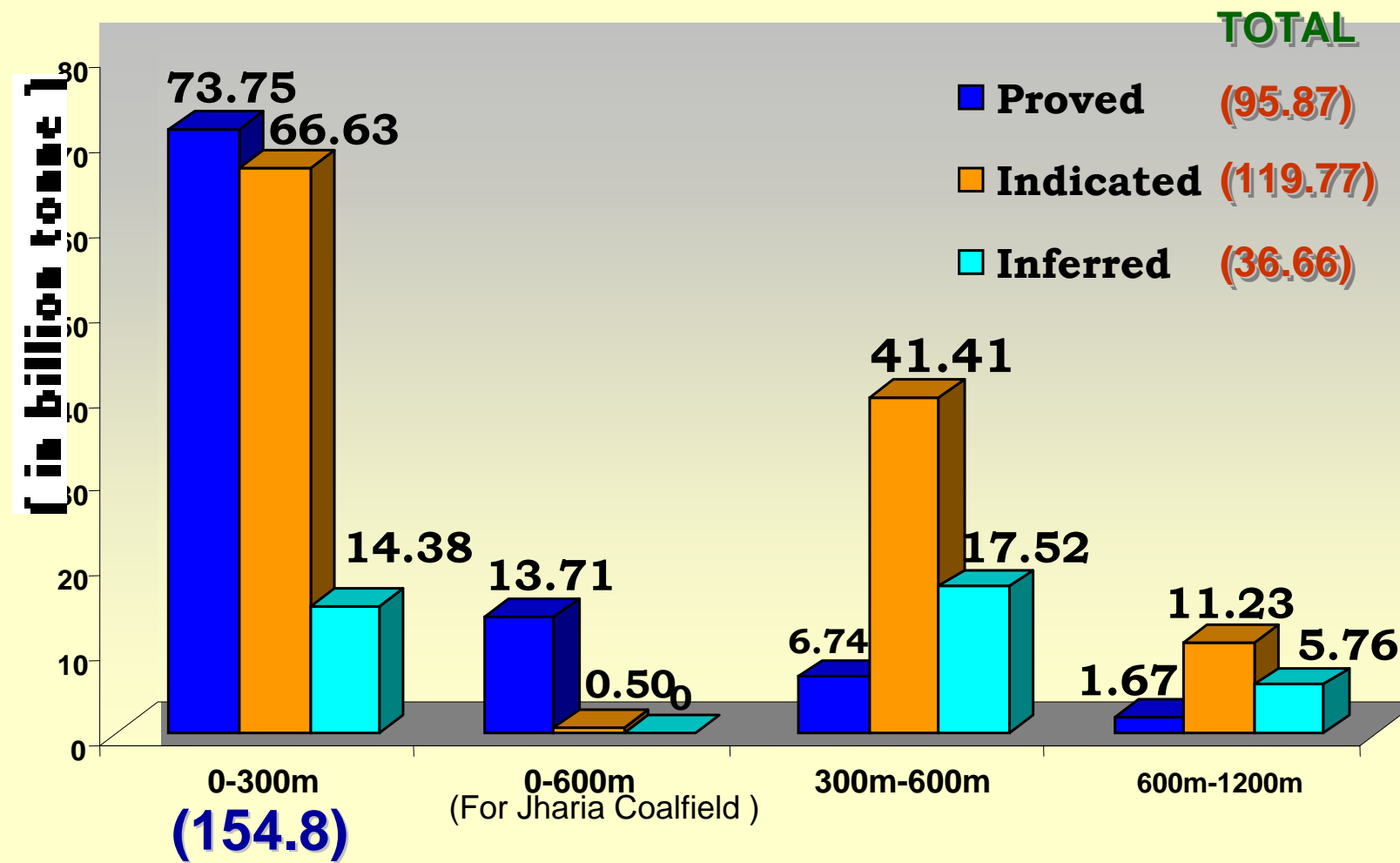
☒ Semi-coking & weakly coking coal

<u>Grade</u>	<u>Ash + Moisture</u>	<u>Sp.Gr</u>
Semi-Coking -I	< 19%	1.44
Semi-Coking -II	19% - 24%	1.46

DEPTH-WISE AND CATEGORY-WISE RESOURCE OF INDIAN COAL

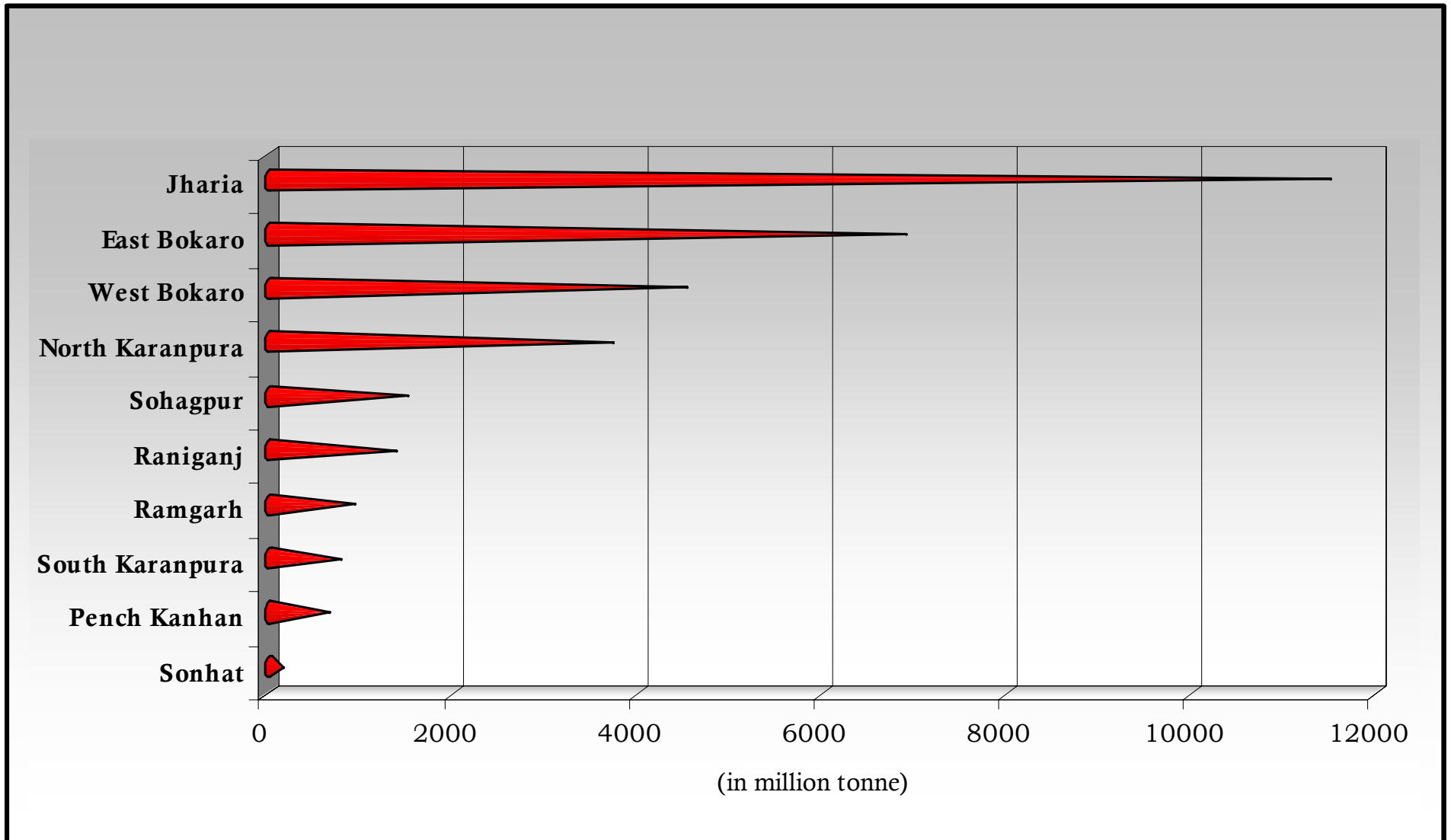
(As on 01-01-2006)

Total Resource : 253.3 b.t.



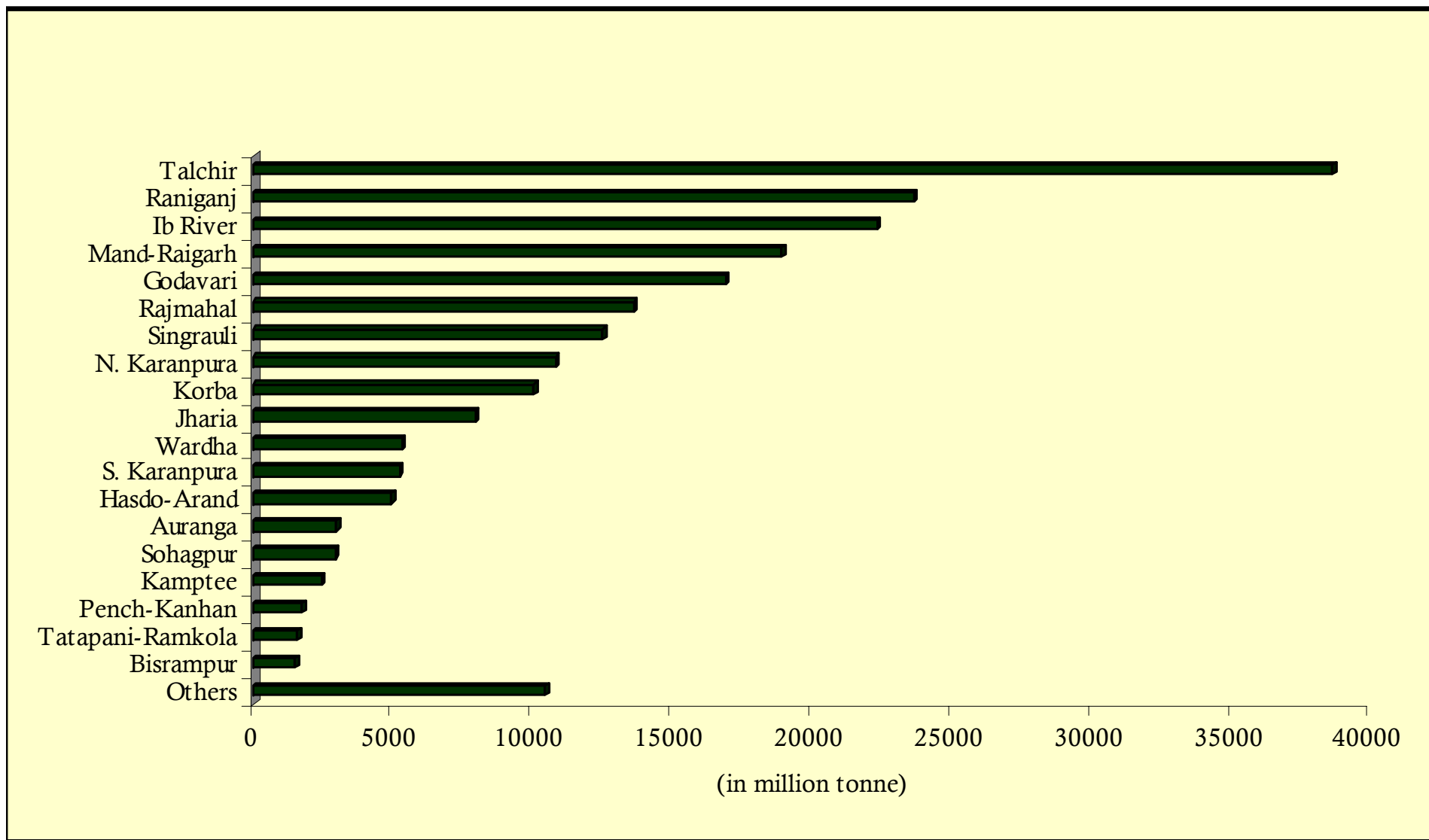
COALFIELD-WISE DISTRIBUTION OF COKING COAL

(As on 01.01.2006)



COALFIELD-WISE DISTRIBUTION OF NON-COKING COAL

(As on 01.01.2006)

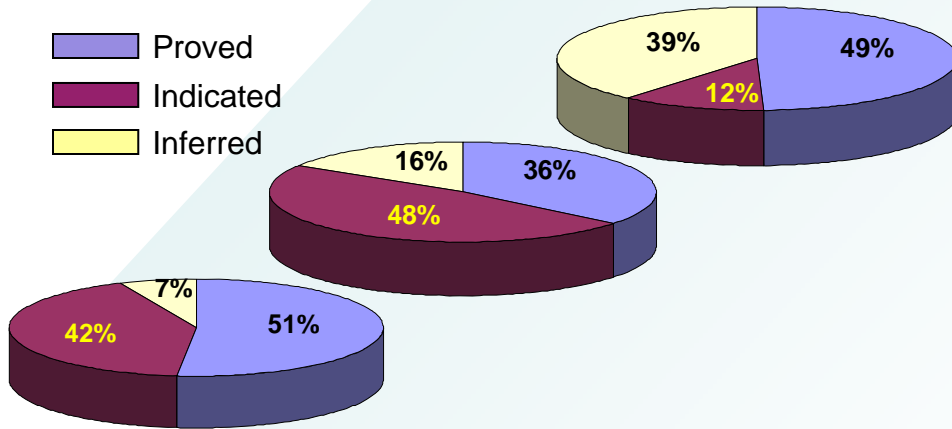


Coal Resource base

253 b. t.
(up to 1200m depth)

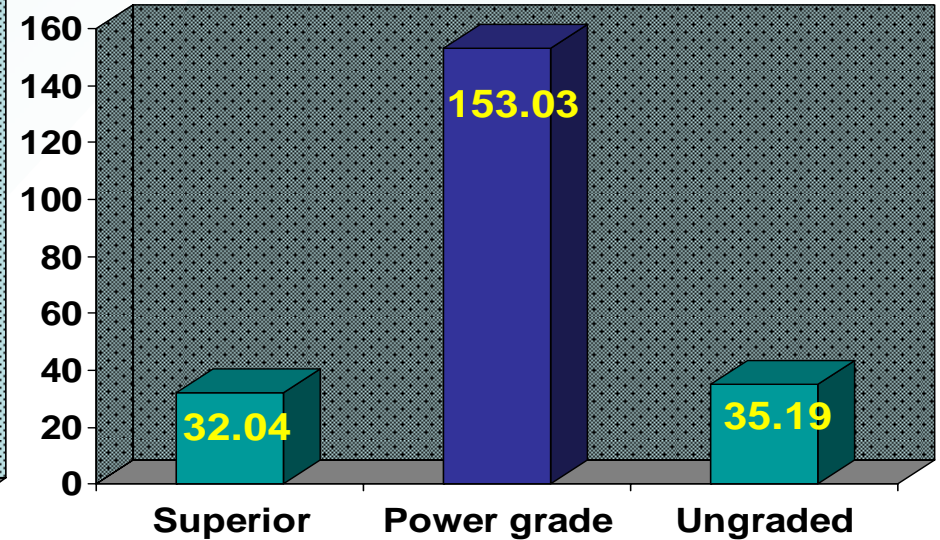
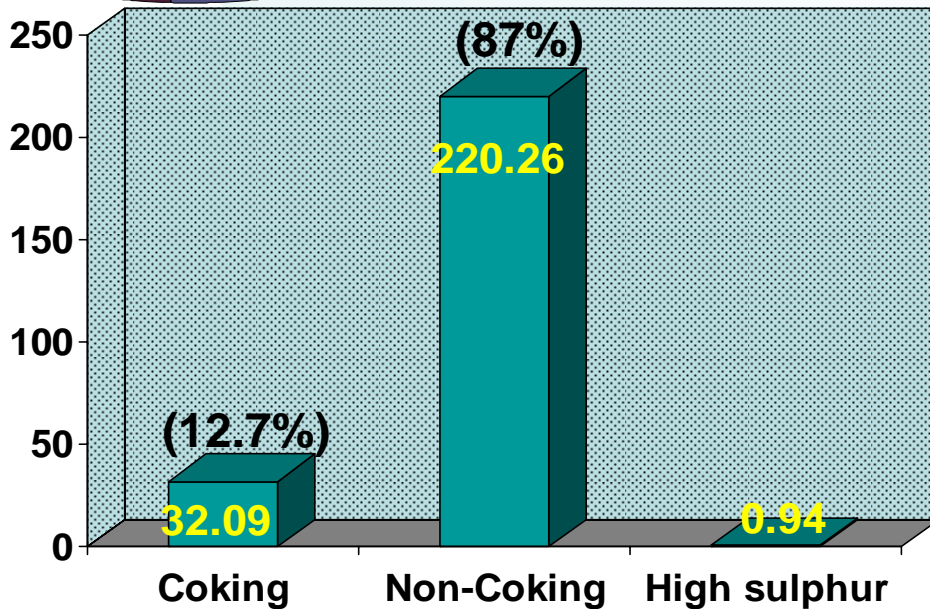
Proved	Indicated	Inferred
95.87 b.t	119.77 b.t	37.67 b.t

■ Proved
■ Indicated
■ Inferred



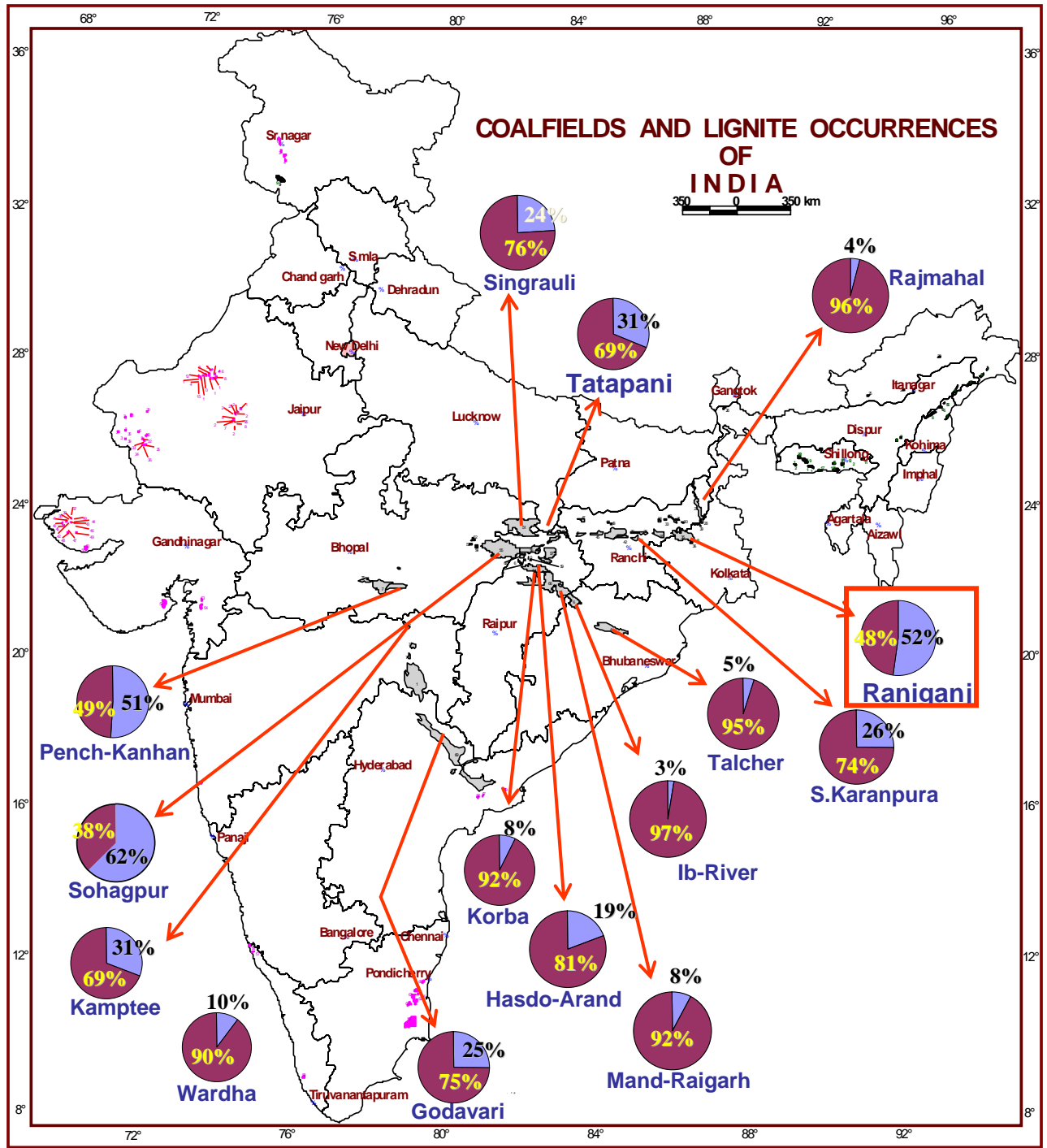
Power grade coal:
153 b. t. (60%)
(up to 1200m depth)

Quality-wise break-up of Non-coking coal



**QUALITY-WISE VARIATION OF
NON-COKING COAL OVER
MAJOR GONDWANA
COALFIELDS OF INDIA**

Superior Non-Coking
 Inferior Non-Coking



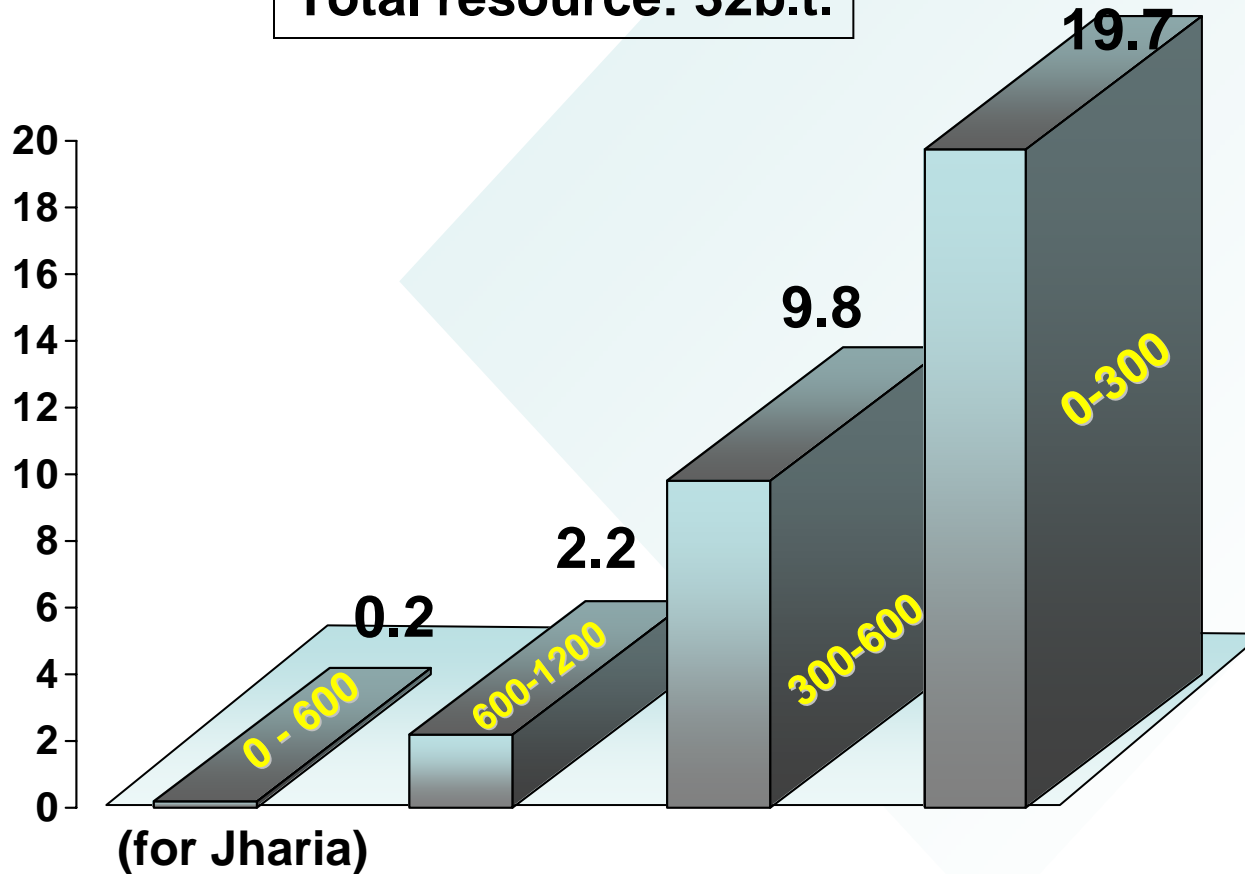
Superior grade coal

('A' - 'C')

UHV:4940K - >6200Cal/Kg

Depth-wise distribution

Total resource: 32b.t.



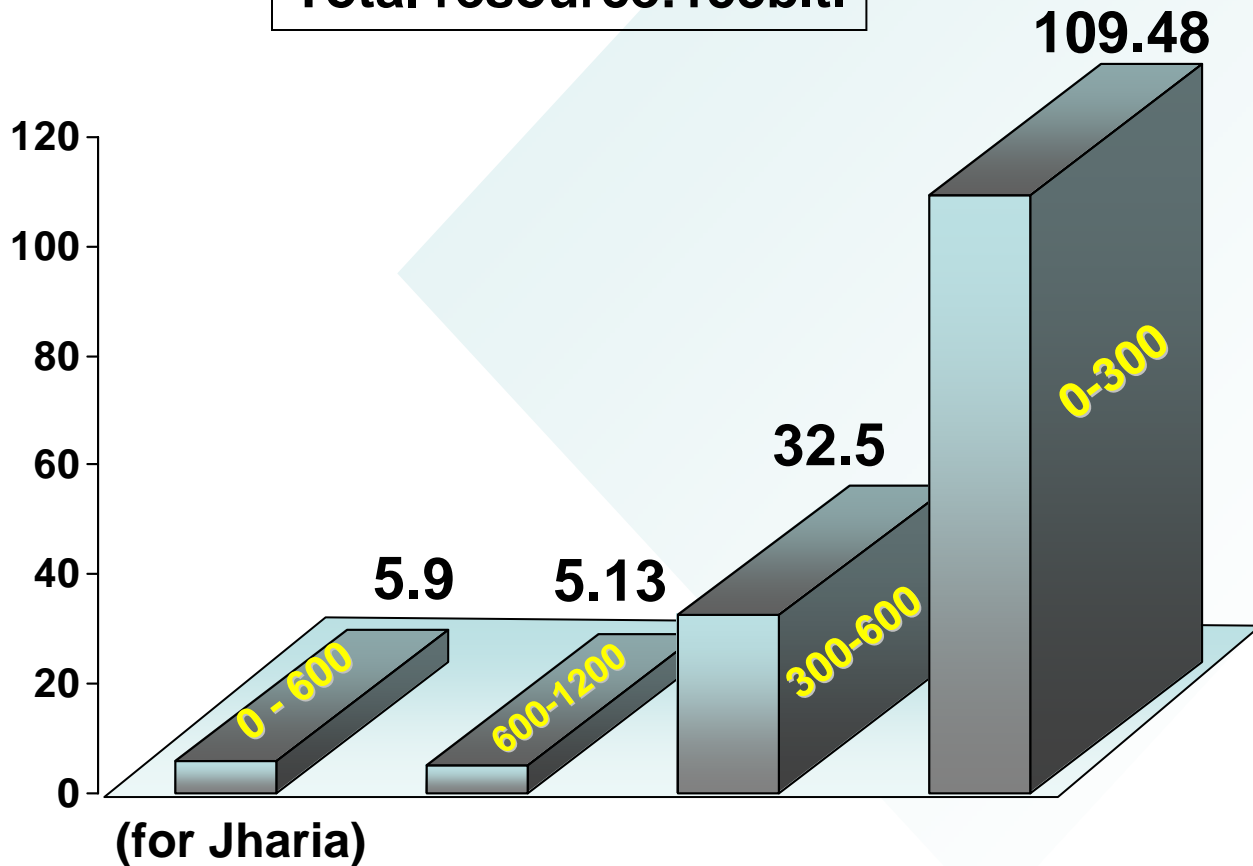
Power grade coal

('D' – 'G')

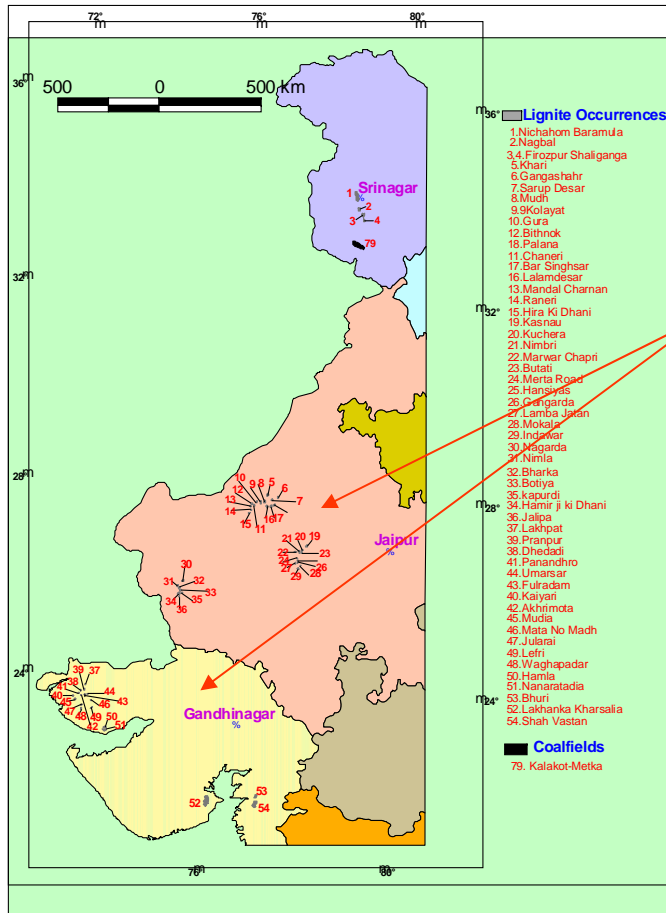
UHV:1300-4940 KCal/Kg

Depth-wise distribution

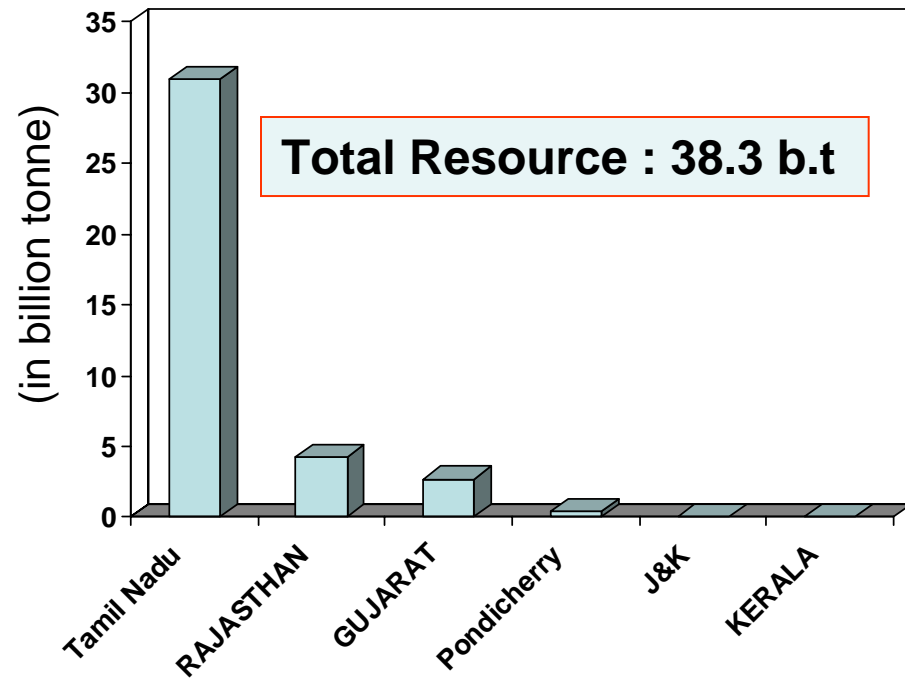
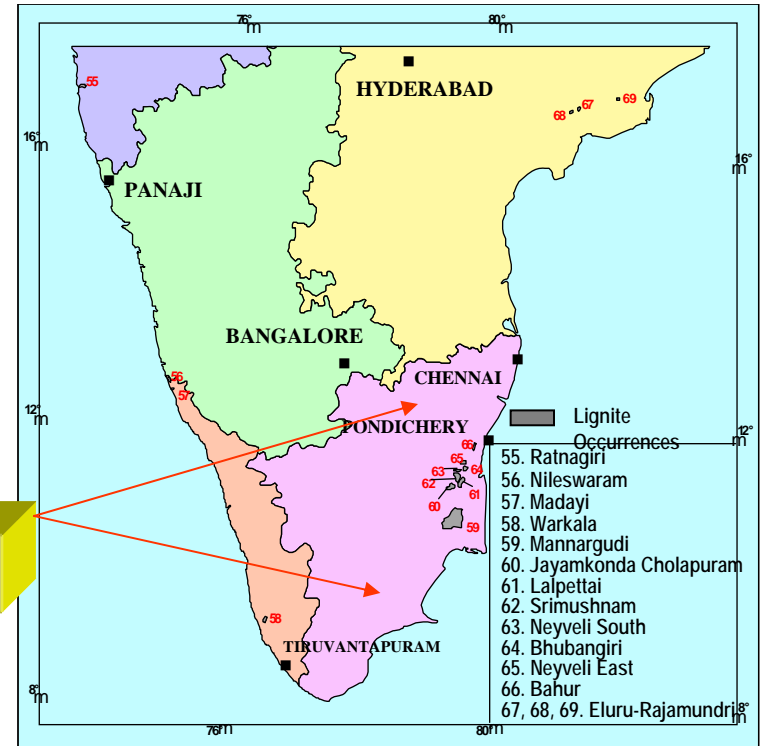
Total resource:153b.t.



Lignite Occurrences



Workable deposits



CRITICAL ANALYSIS OF RESOURCE SCENARIO

vis-à-vis

UNDERGROUND COAL GASIFICATION

UNDERGROUND COAL GASIFICATION

CONCEPT ~ CONVERTING IN-SITU COAL SEAMS INTO A
COMBUSTIBLE CLEAN GAS

UNIQUE FEATURE ~ EXPLOITATION OF UNMINEABLE
DEEP SEATED COAL SEAMS

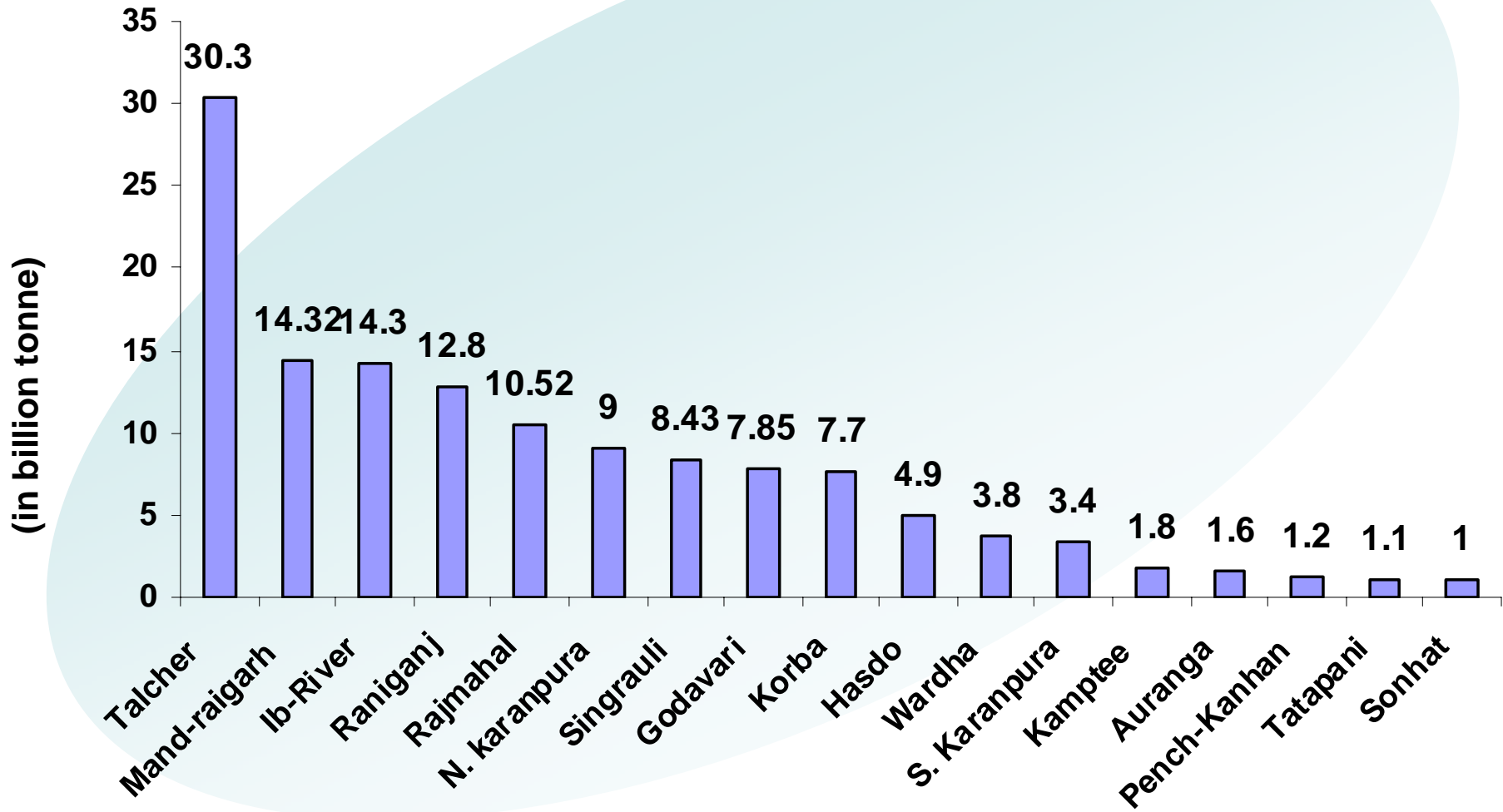
CONSTRAINT ~ DEVELOPMENT OF RELIABLE WORKING
PROGRAMME WITH ECONOMIC VIABILITY

SUBSTANTIAL RESOURCE NOT MINEABLE ~

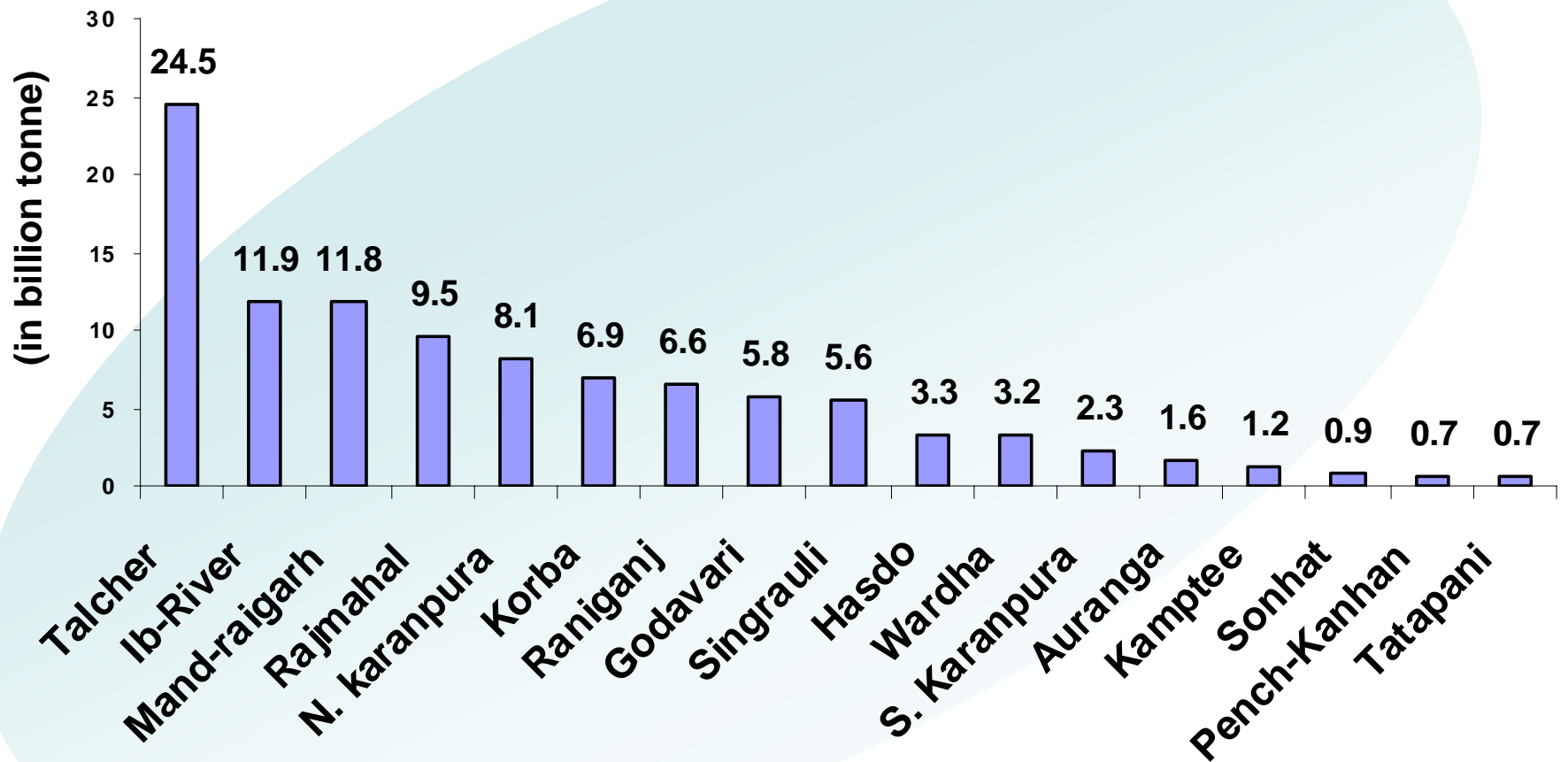
**SURFACE CONSTRAINTS, SAFETY
AND TECHNOLOGICAL REASONS**

**21% OF NET IN-SITU PROVED
RESOURCE EXTRACTABLE WITHIN
PRESENT MINING TECHNOLOGY
(SOURCE CMPDI)**

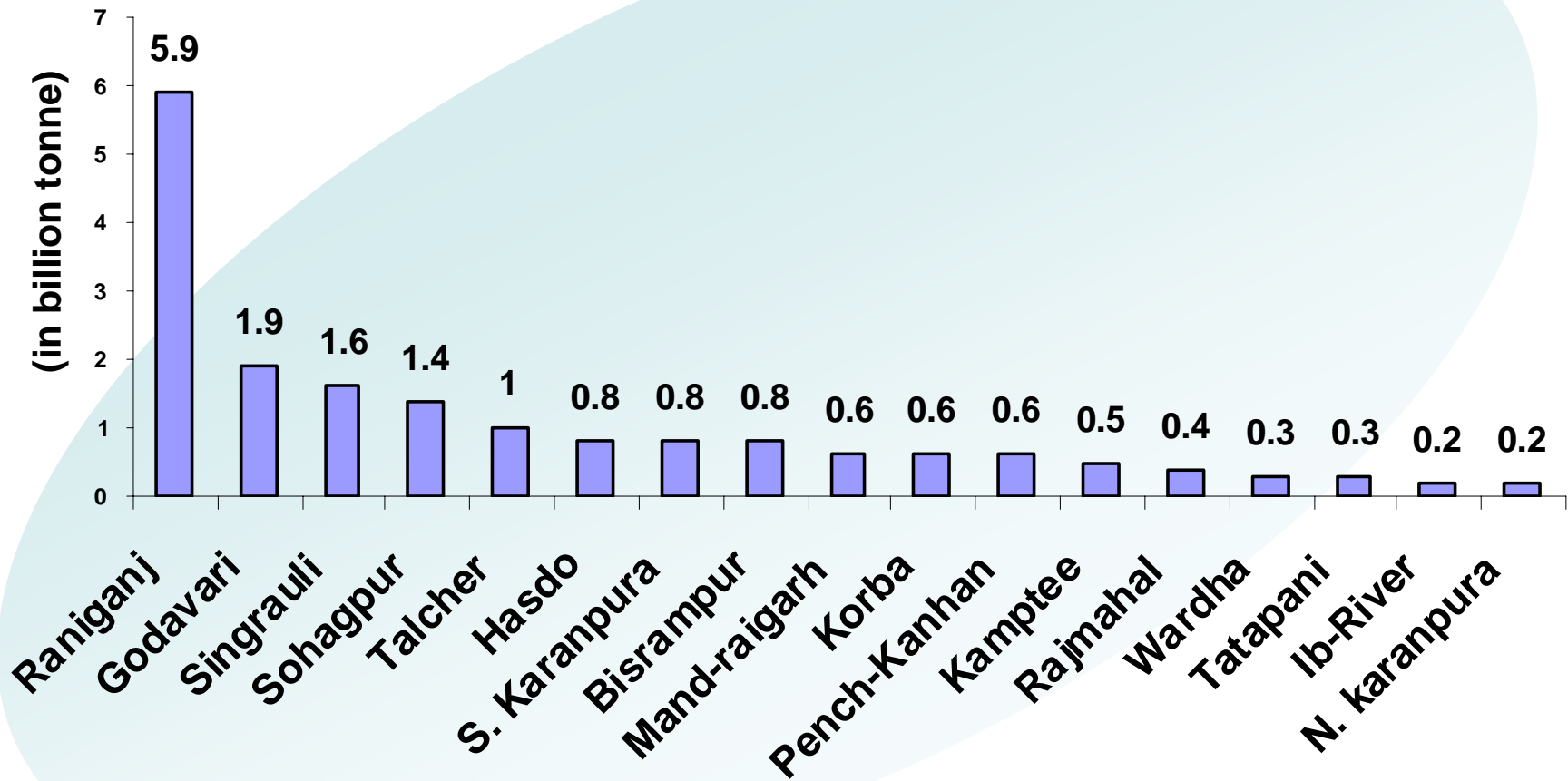
Distribution of non-coking coal in major Coalfield within 0-300m



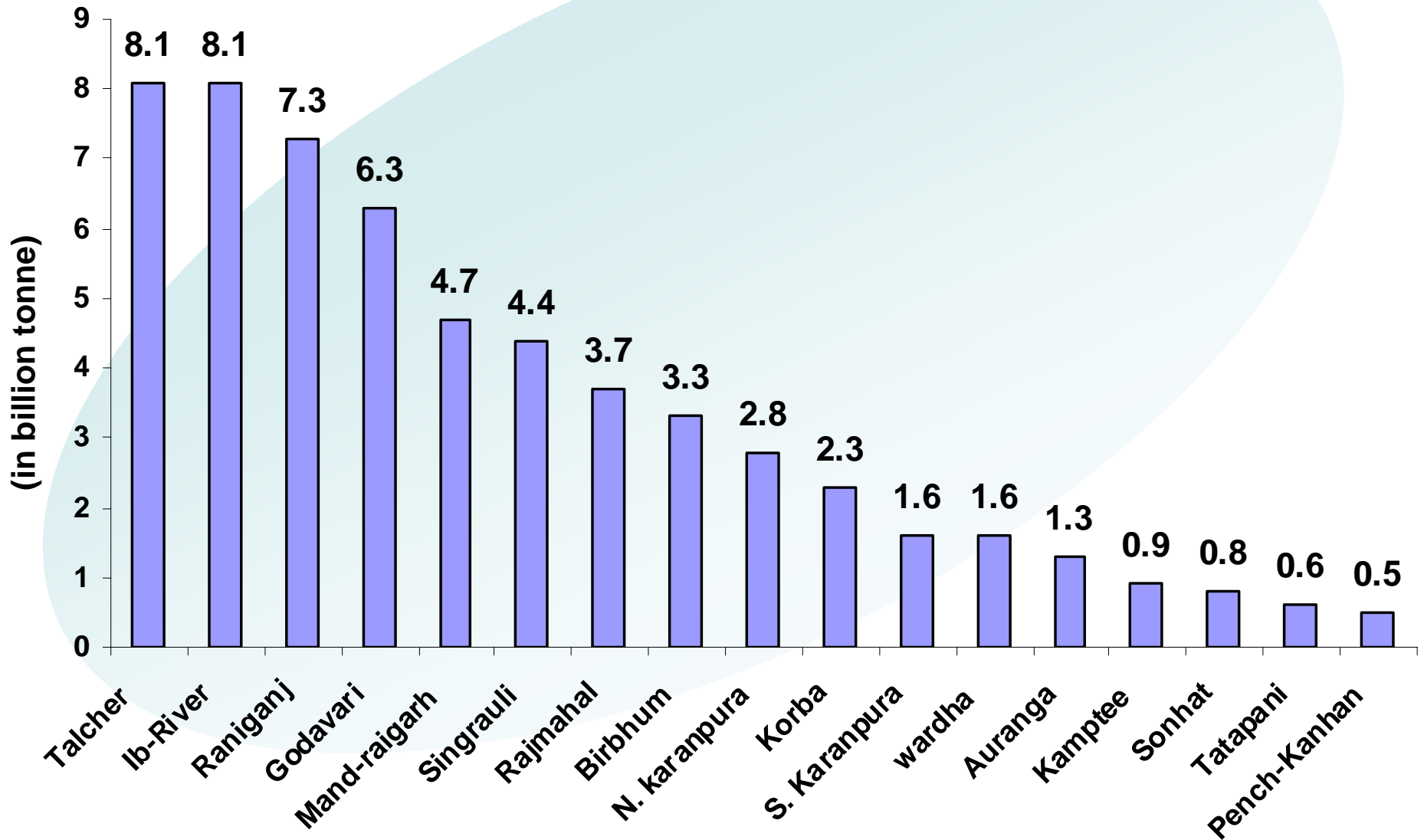
Distribution of Power grade coal in major Coalfield within 0-300m



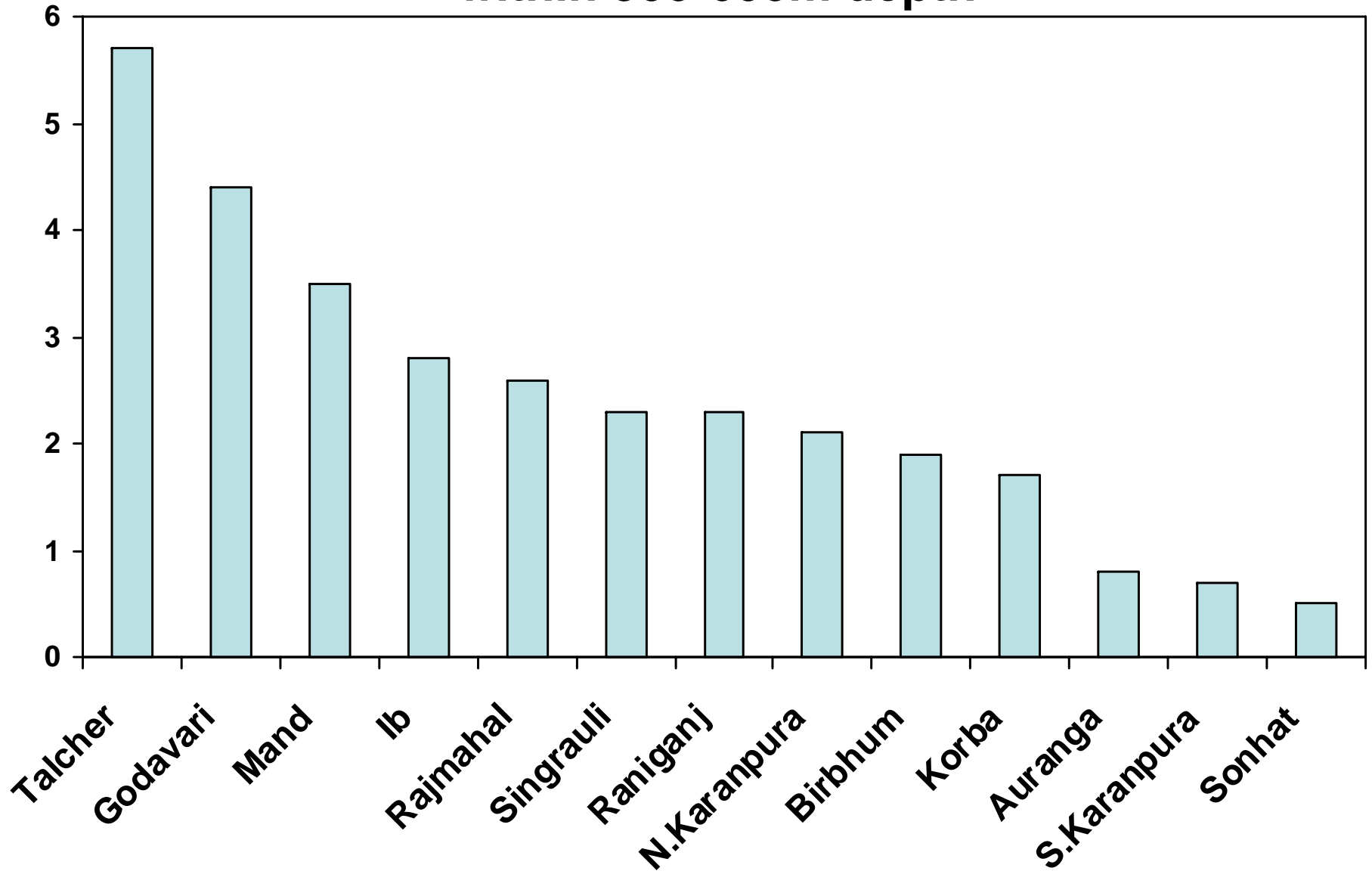
Distribution of Superior grade coal in major Coalfield within 0-300m



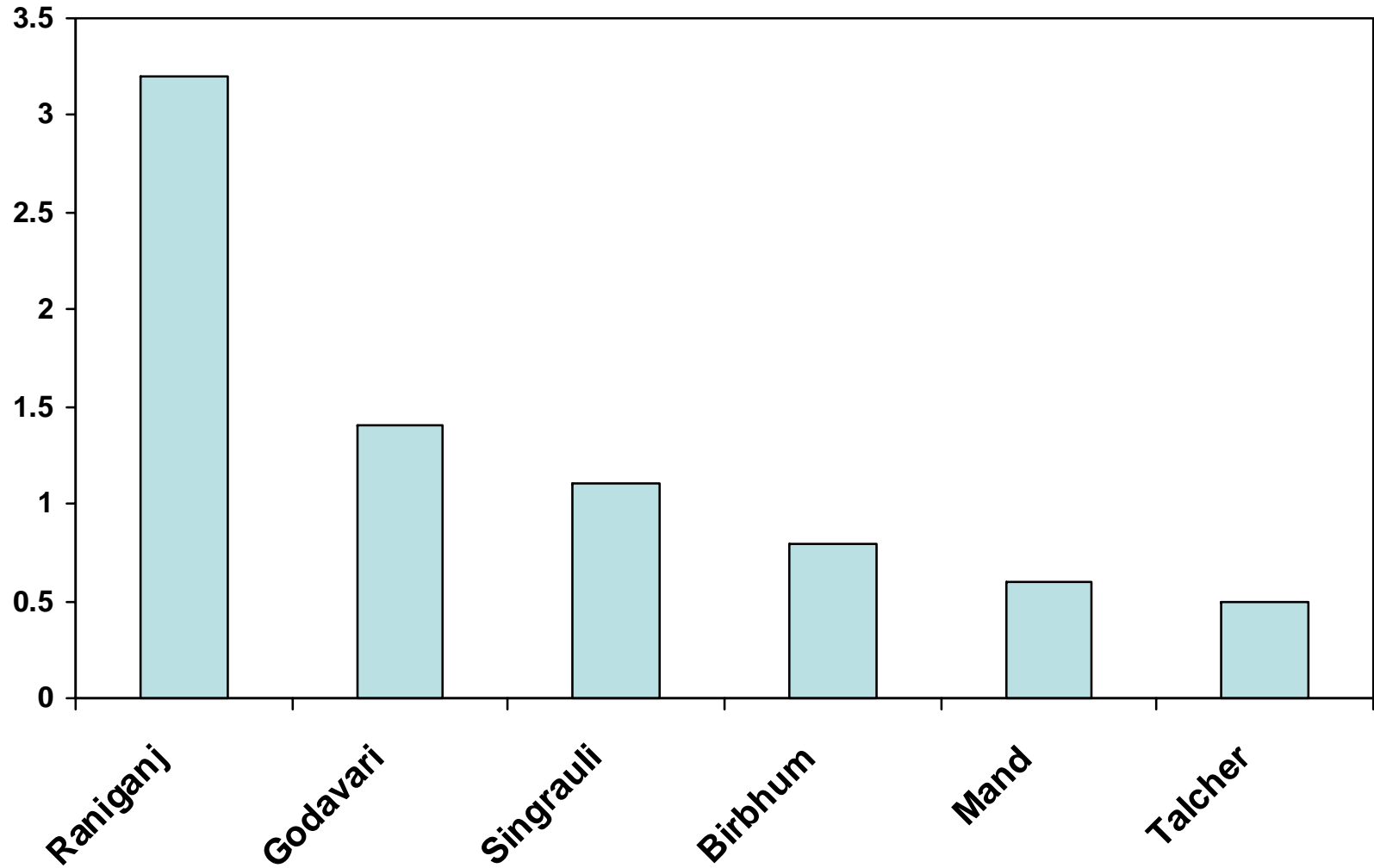
Distribution of non-coking coal in major Coalfield within 300-600m



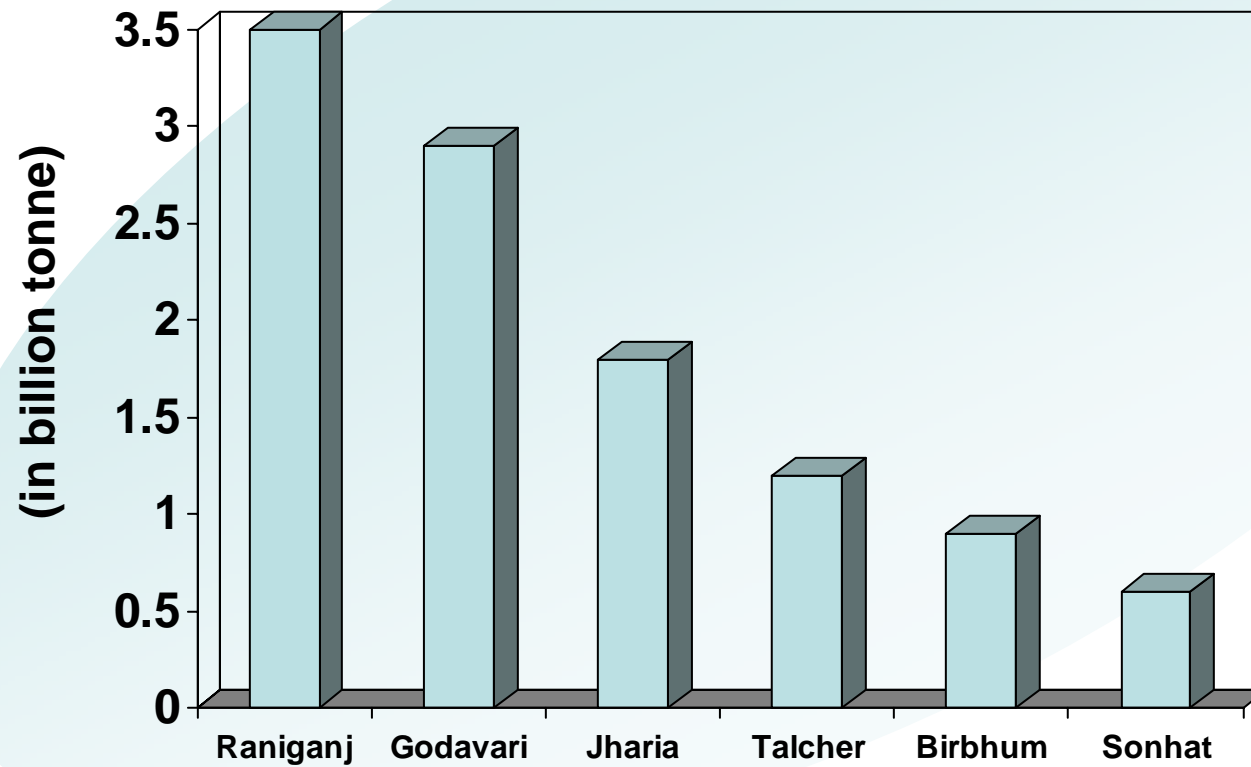
Coalfield-wise distribution of Power grade coal within 300-600m depth



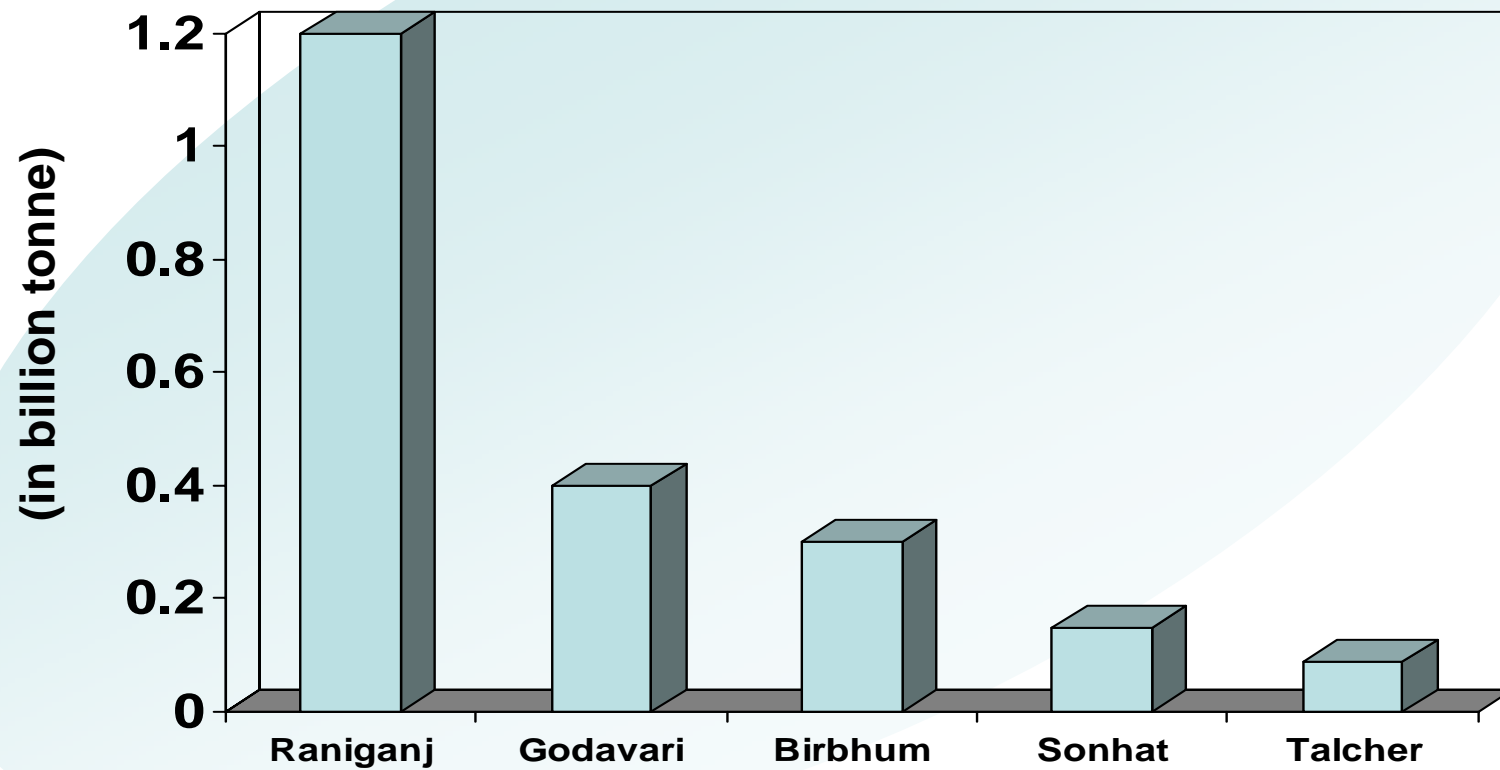
Coalfield-wise distribution of Superior grade coal within 300-600m depth



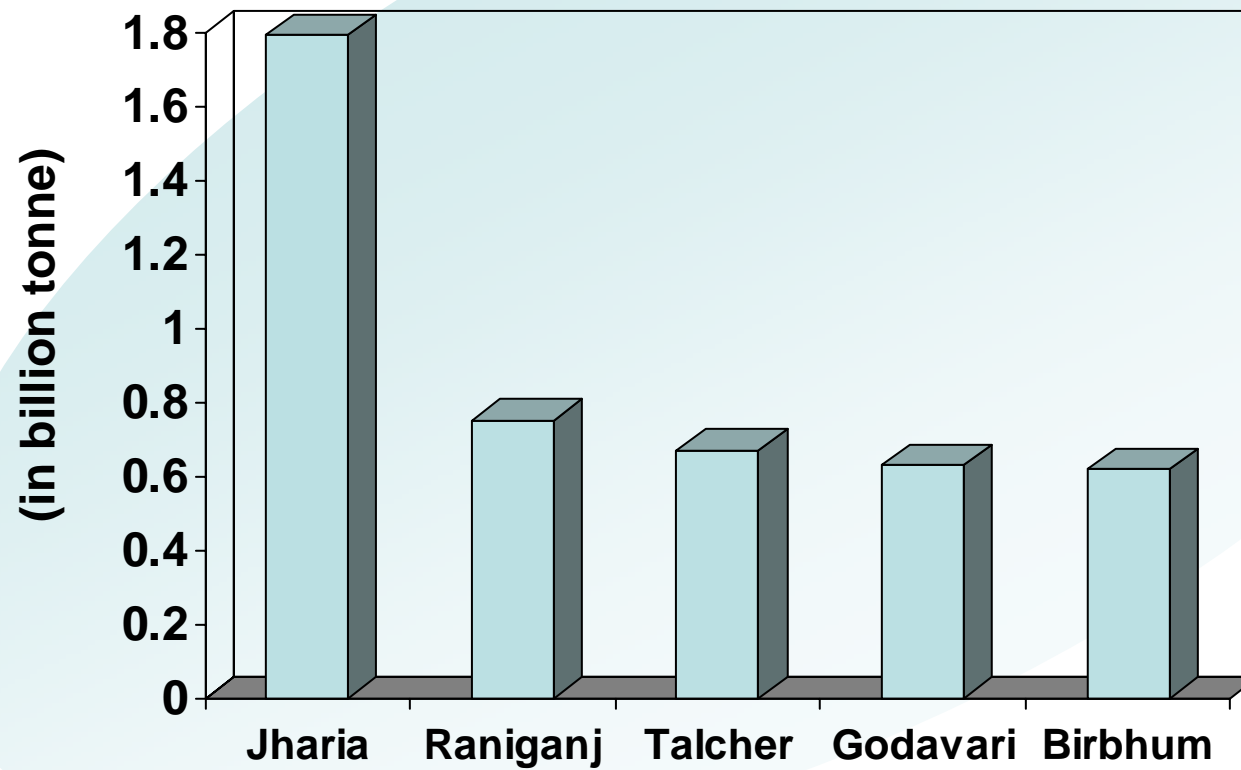
Distribution of non-coking coal in major Coalfield within 600-1200m



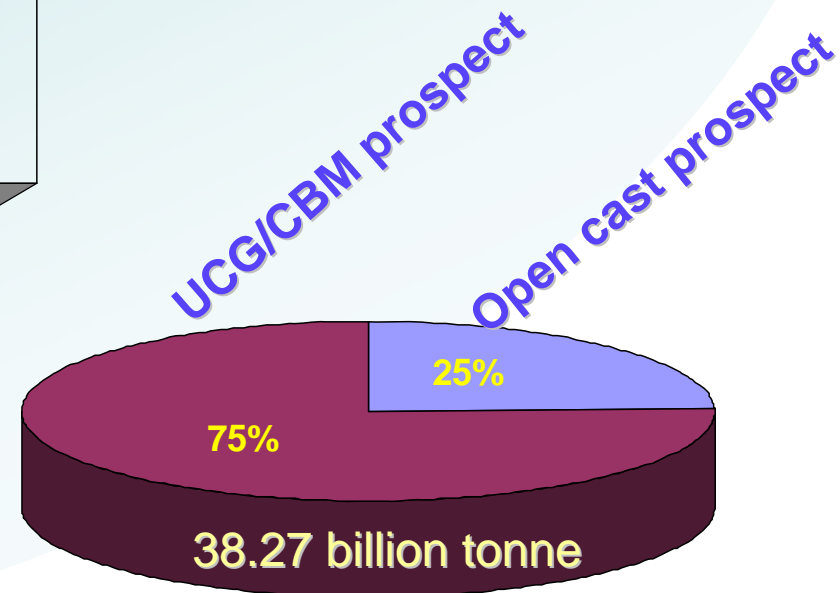
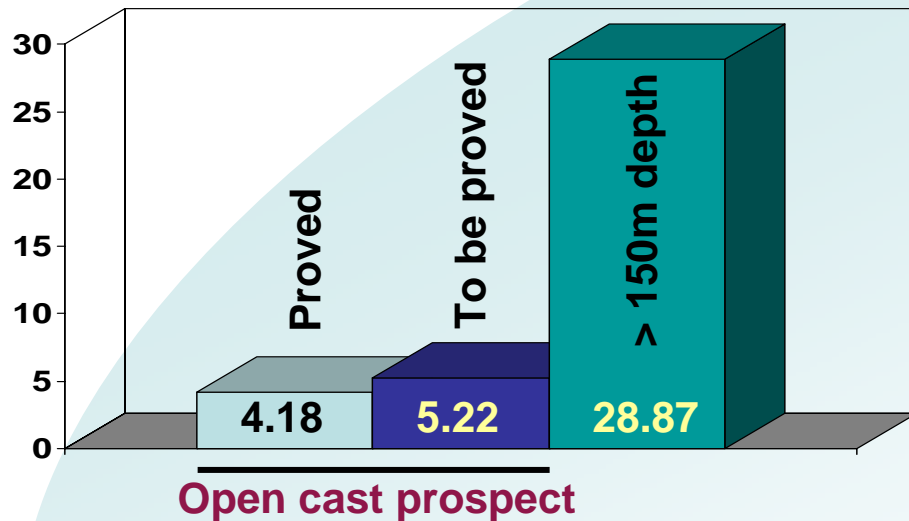
**Distribution of Superior grade coal in major Coalfield
within 600-1200m**



Distribution of power grade coal in major Coalfield within 600-1200m



**Out of total lignite resource (38.27 billion tonne)
9.4 billion tonne are of quarriable prospect**



EMERGING POSSIBILITIES OF EXPLOITING SOLID FOSSIL FUEL THROUGH UCG

requires

Characterisation of resource on chemical and petrographic parameters at exploration stage

for

Optimal utilisation of resource both at short and long term perspective

DESIRABLE COAL CHARACTERS

- **COAL WITH HIGHER REACTIVITY ~ COAL WITH SIGNIFICANT AMOUNT OF EXINITE/LIPTINITE**
- **COAL WITH HIGH MOISTURE CONTENT ~ REACTION REQUIRES WATER**
- **COAL TYPE - LOW RANK COAL EASILY GASIFIED**
- **CAKING OR SWELLING SHOULD BE LESS**

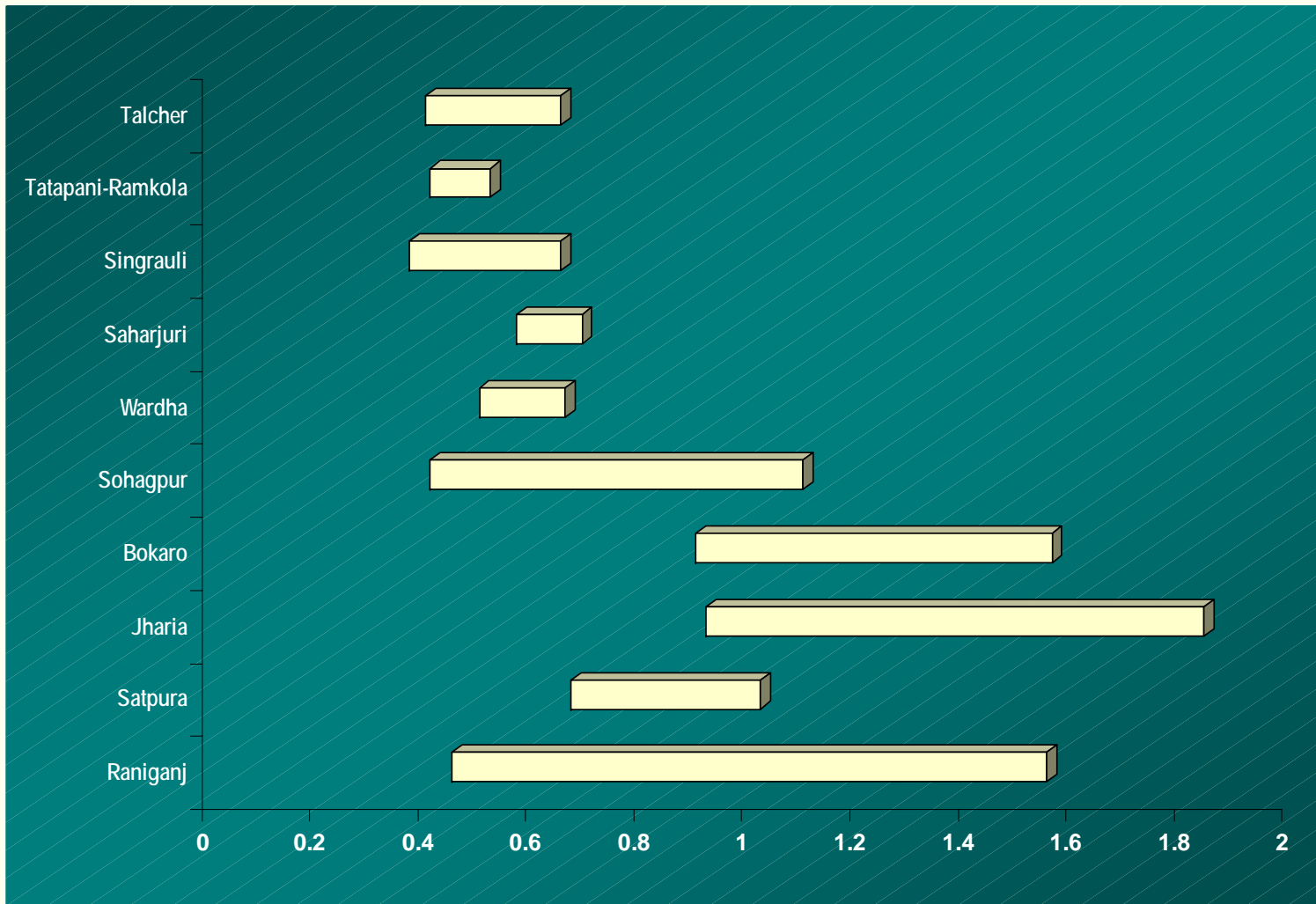
DESIRABLE COAL CHARACTERS (CONTD.)

- **MINERAL MATTER AND ASH FUSION TEMP. ARE IMP. FACTORS**
- **COAL NEED TO BE ADEQUATELY PERMEABLE**
- **FOR COAL HYDROGENATION DESIRABLE ELEMENTS**
 - VITRINITE REFLECTANCE < 0.8%**
 - VITRINITE + EXINITE > 60%**
 - VM > 35% ; H/C ATOMIC RATIO >0.75%**

Generalised character of Coal / Lignite seams of some of the coal/lignite fields

Coal	Vitrinite%	Inertinite%	Exinite%	VM%	C%	H%
Hasdo-Arand	31–49	24–47	10–22	21-38	79 – 83	4.7–5.0
Mand-Raigarh	43–60	22–43	15–25	-	78 – 81	5.0– 5.3
Tatapani-Ramkola	8–16	41–51	16–18	-	-	-
Sohagpur	21–53	37–63	16–25	33-40	79 – 91	4.9–5.2
Bisrampur	25–30	55–60	10-15	35-38	78 – 85	4.2–4.8
Wardha	25–35	50–55	15–20	29-45	76 – 81	4.3–5.1
Talcher	33–60	30–55	15–25	35-45	79 – 82	4.9–5.3
Godavari	35–45	40–60	5–15	35 - 42	78 - 85	4.2–5.4
Lignite						
Ramnad	60 – 80	5 – 6	10 – 20		-	-
Mannargudi	80	5	12			

*RANGE OF VARIATION OF VITRINITE
REFLECTANCE (R_o%) IN DIFFERENT COALFIELDS*



MAJOR COALFIELDS (Resource > 300m)

(COAL SEAMS >3M THICK OF BARAKAR AND RANIGANJ/KAMTHI FMS.)

- **RAJMAHAL-BIRBHUM CF**
- **RANIGANJ CF**
- **JHARIA, N KARANPURA, S KARANPURA, AURANGA**
- **TALCHER AND IB**
- **MAND RAIGARH , KORBA**
- **GODAVARI VALLEY**
- **SINGRAULI**

 **Around 29 b. t. of lignite resource >150m (mainly in Tamil Nadu)**

 **Huge deposit of lignito-bituminous coal and lignite of Cambay basin and Sanchor basin within 700-1700m**

INDIAN COAL RESOURCES SUITABLE FOR UCG

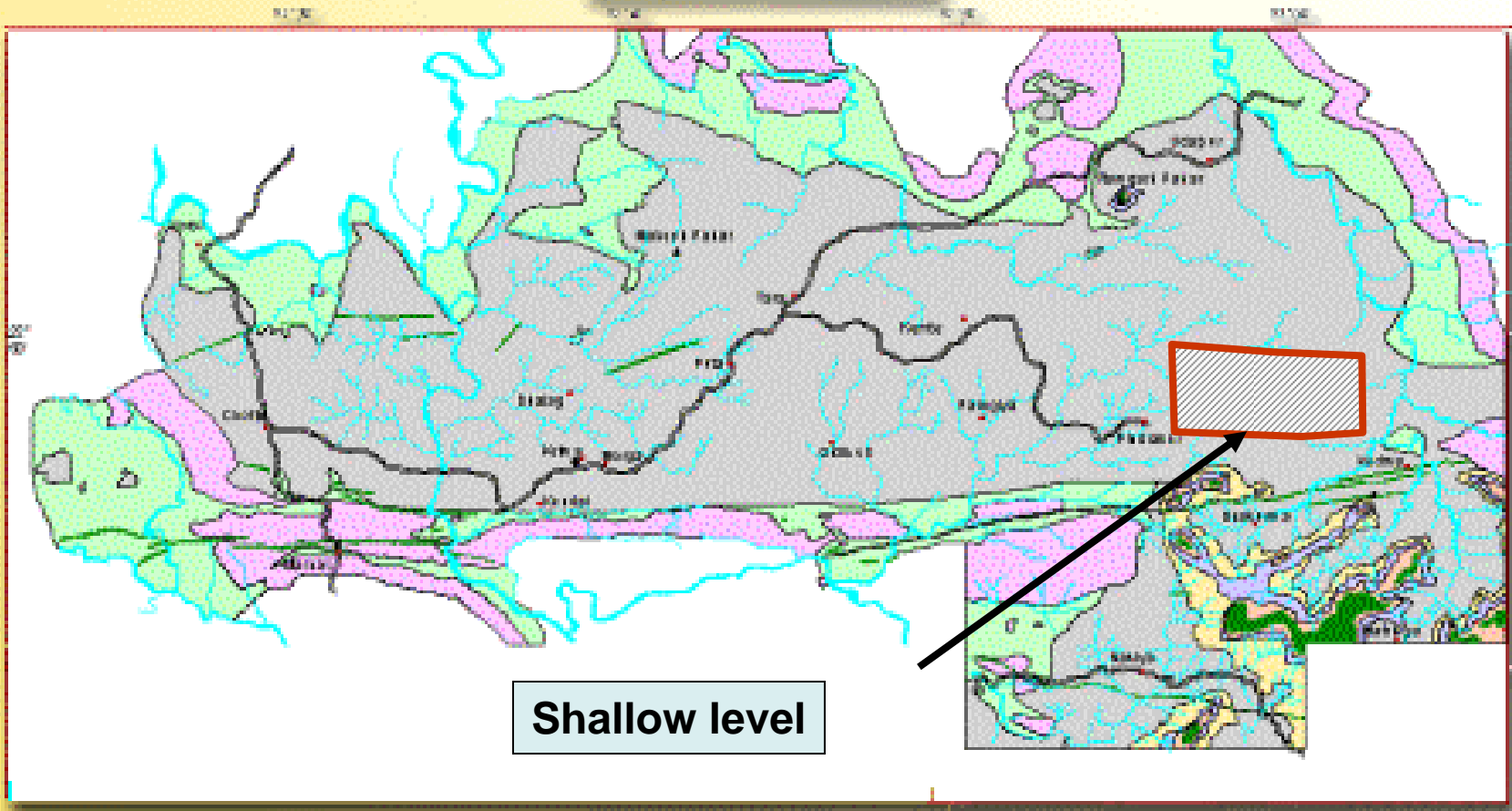
- **UNMINEABLE PART OF THE SHALLOW LEVEL RESOURCE**
- **SUBSTANTIAL SHARE (36%) OF TOTAL RESOURCE (253 BT) CONTAINED IN DEPTH LEVEL BEYOND 300M**

POSSIBLE AREAS FOR SHALLOW LEVEL COAL RESOURCE








- ▶ *Eastern part of Hasdo-Arand Coalfield*
- ▶ *Southwestern part of Sohagpur Coalfield*
- ▶ *Central part of Talcher Coalfield*
- ▶ *Southcentral part of Singrauli Coalfield*
- ▶ *Western part of Rajmahal Coalfield*

GEOLOGICAL MAP OF HASDO-ARAND COALFIELD, MADHYA-PRADESH

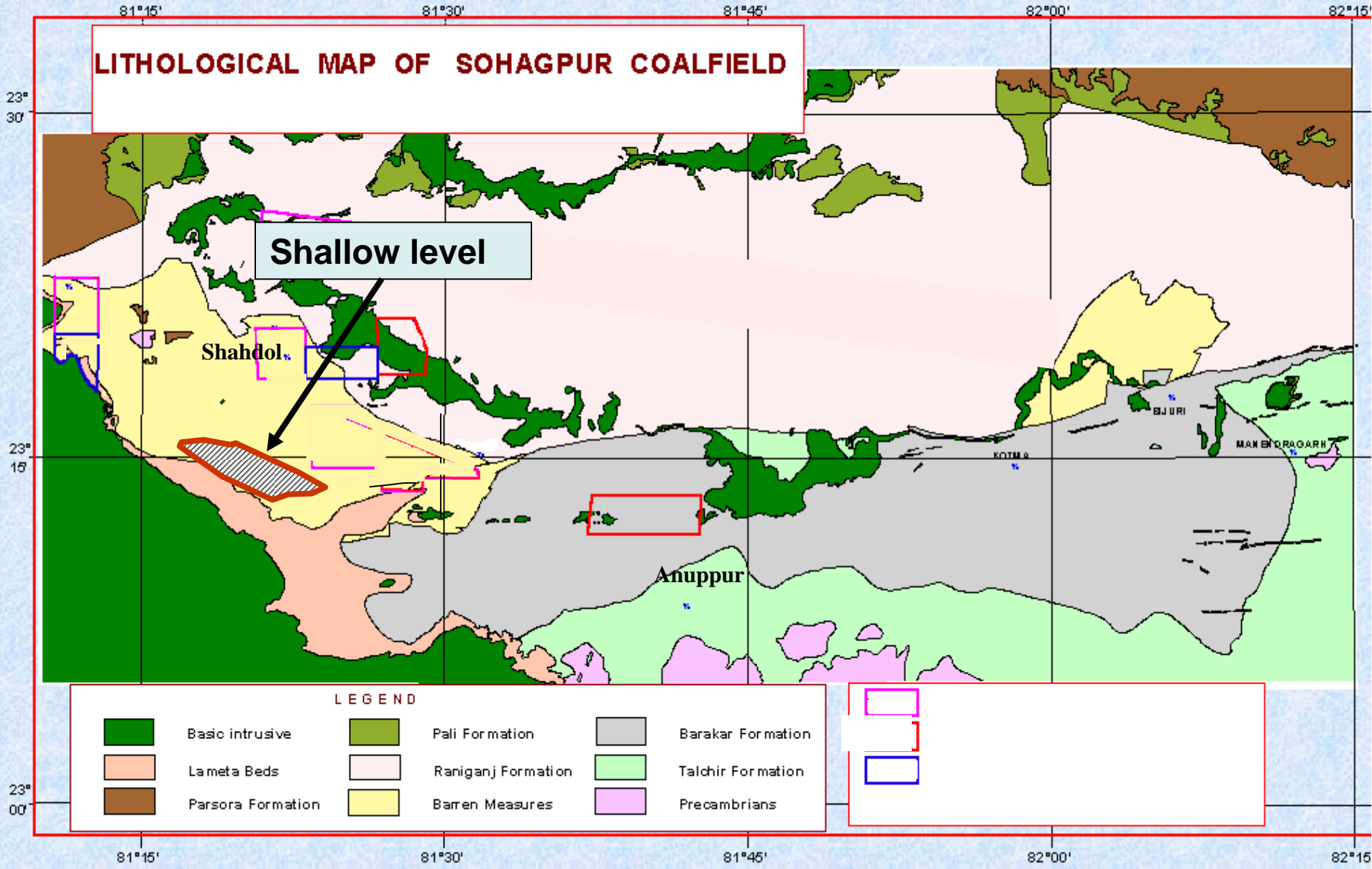
0 6Km





Shallow level

- | | | |
|---|---|--|
|  Deccan Trap(Int rusive/Extrusive) |  Barren Measures |  Archean Basement |
|  Kamthi Formation |  Barakar Formation | |
|  Raniganj Formation |  Talchir Formati on | |

LITHOLOGICAL MAP OF SOHAGPUR COALFIELD

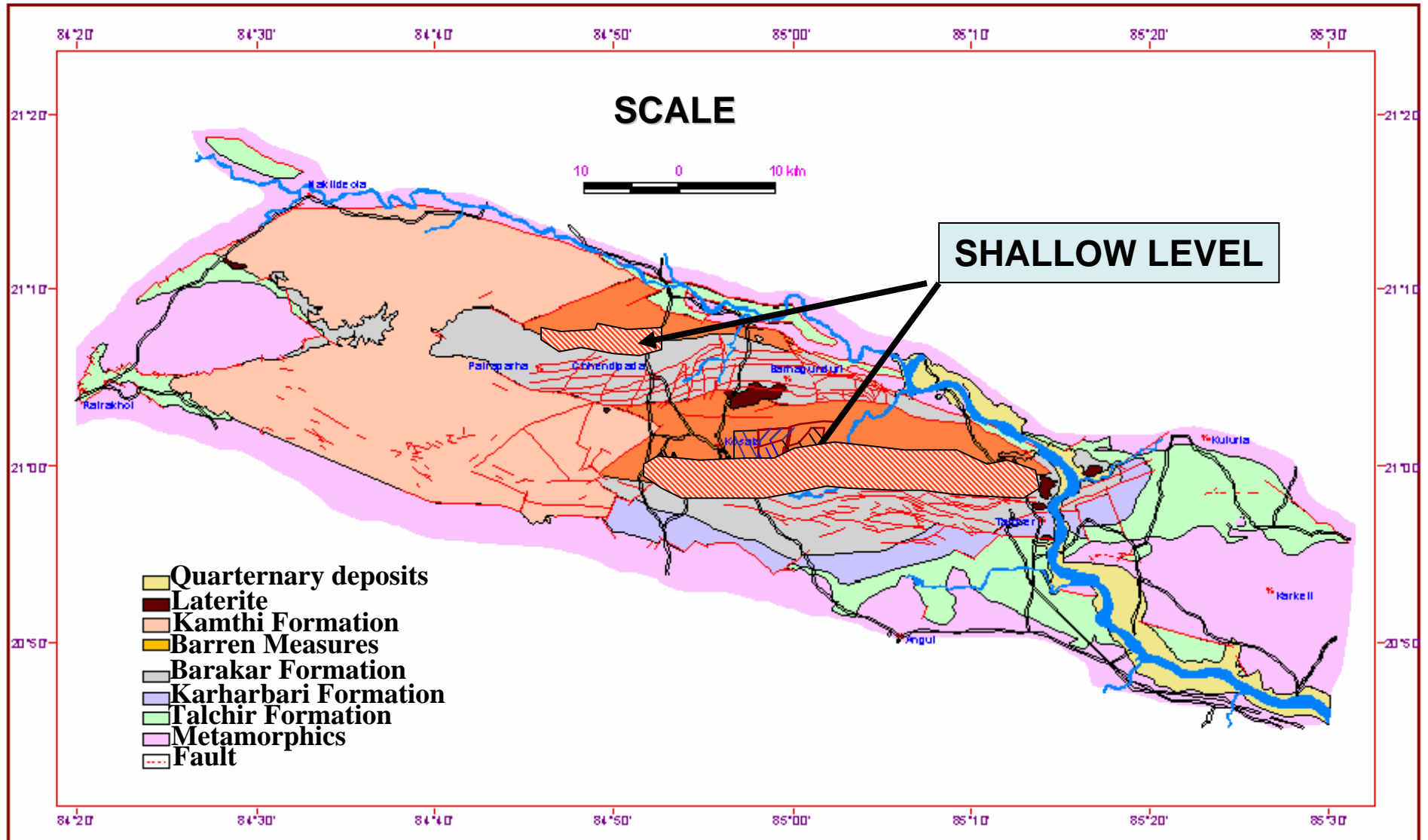


LEGEND

	Basic intrusive		Pali Formation		Barakar Formation
	La meta Beds		Raniganj Formation		Talchir Formation
	Parsora Formation		Barren Measures		Precambrians



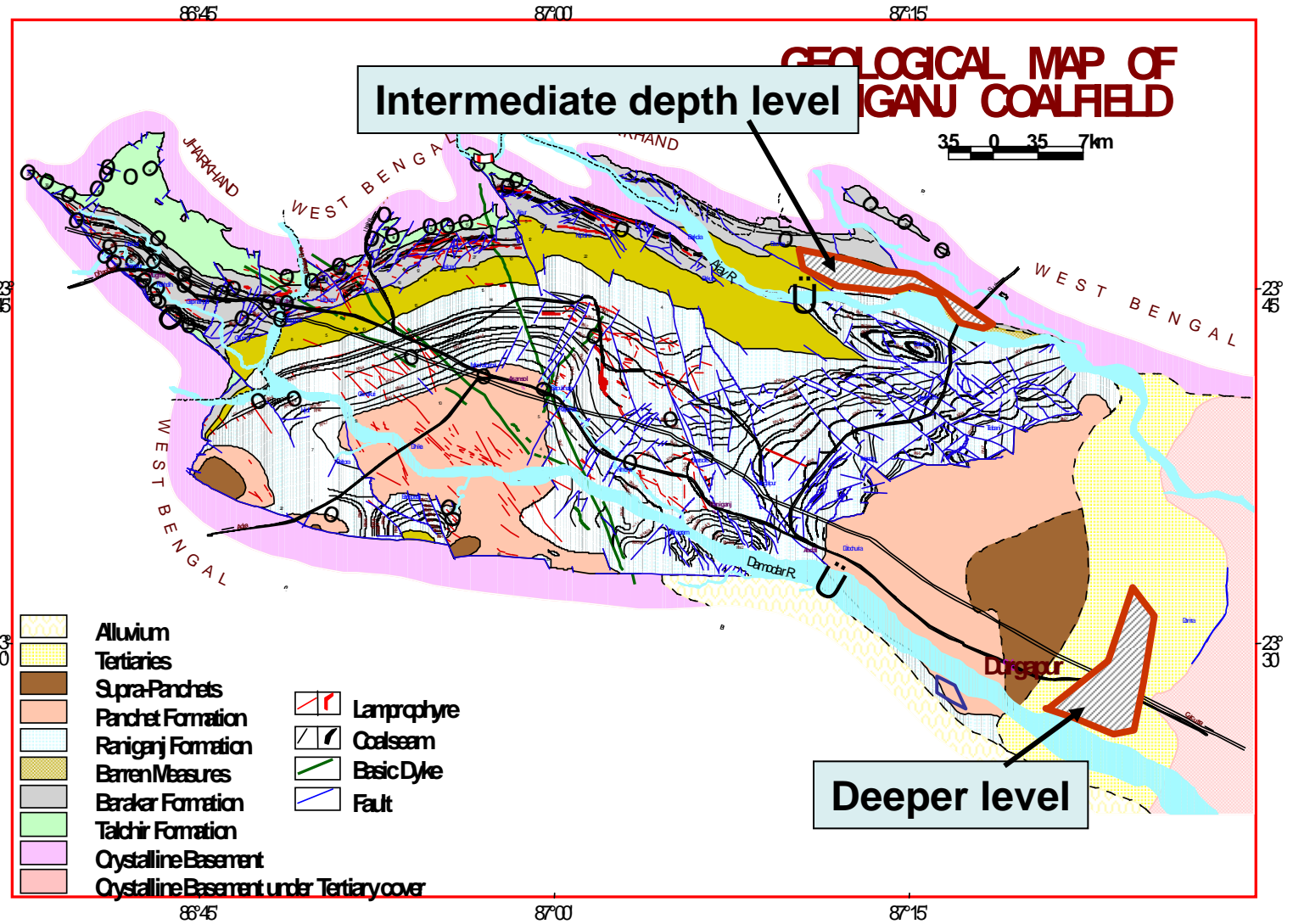
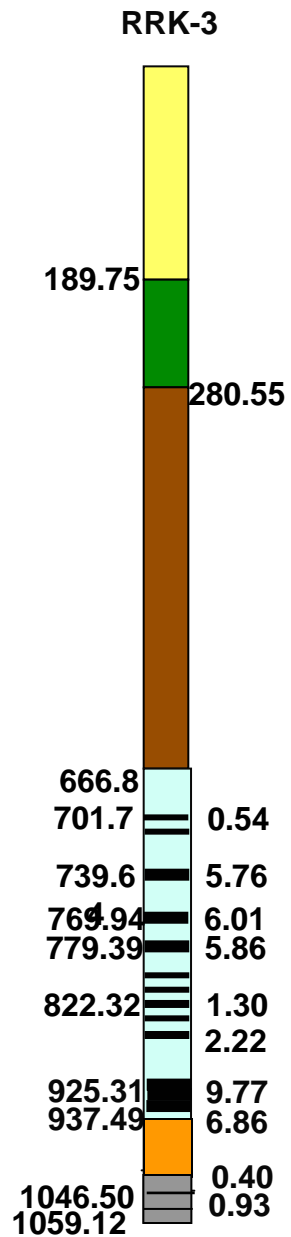
GEOLOGICAL MAP OF TALCHER C F



POSSIBLE AREAS FOR DEEPER (>300M) LEVEL COAL RESOURCE

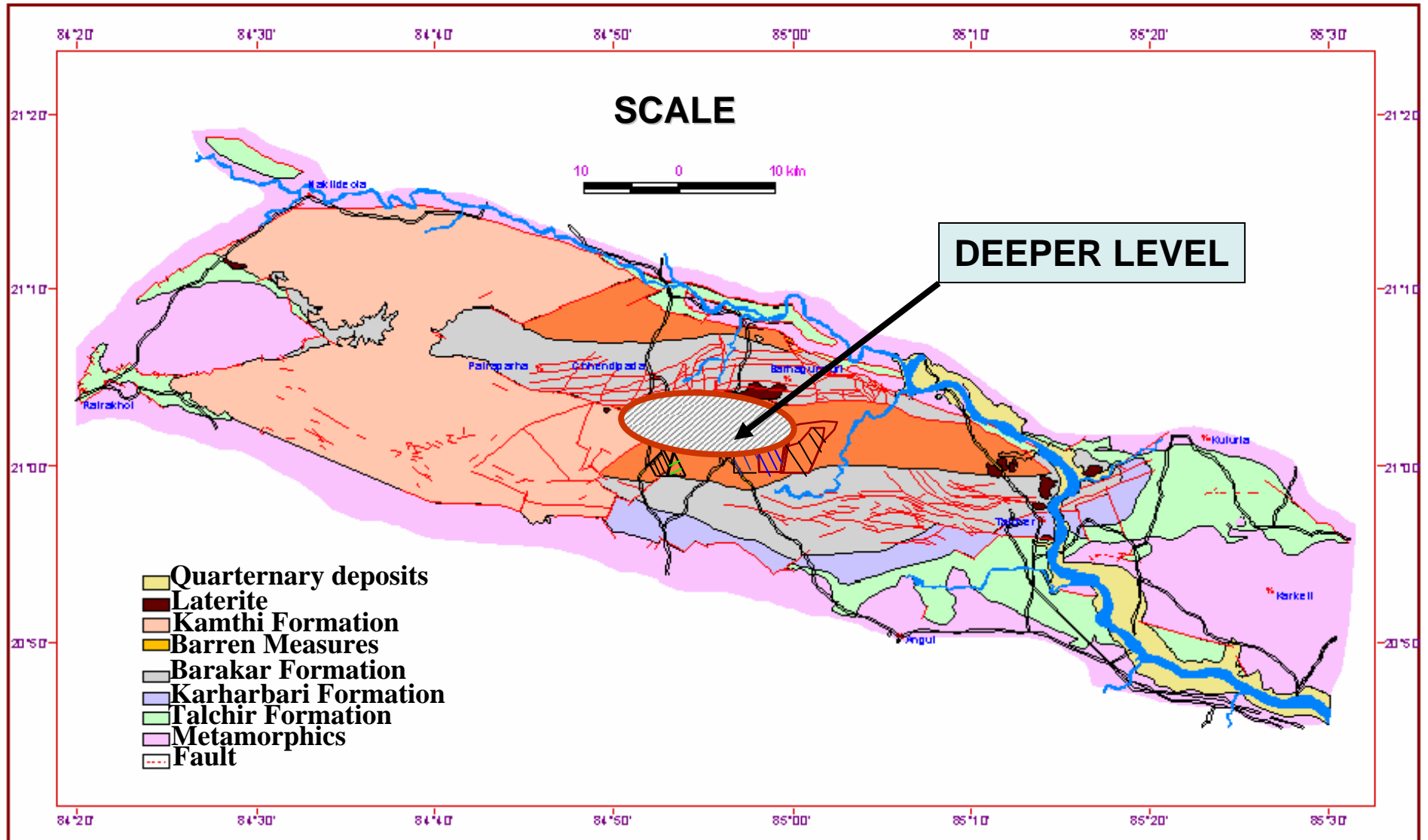
- *Eastern part of Raniganj Coalfield*
- *Western part of Ib-River & Talcher Coalfield*
- *Westcentral part of Mand-Raigarh Coalfield*
- *Central part of main basin, Singrauli Coalfield*
- *Eastern part of Birbhum-Rajmahal Coalfield*
- *Eastern part of Pench-Kanhan Coalfield*
- *central part of north Godavari Coalfield*

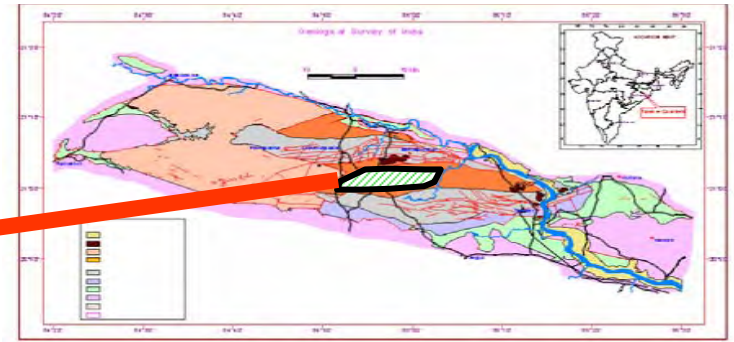
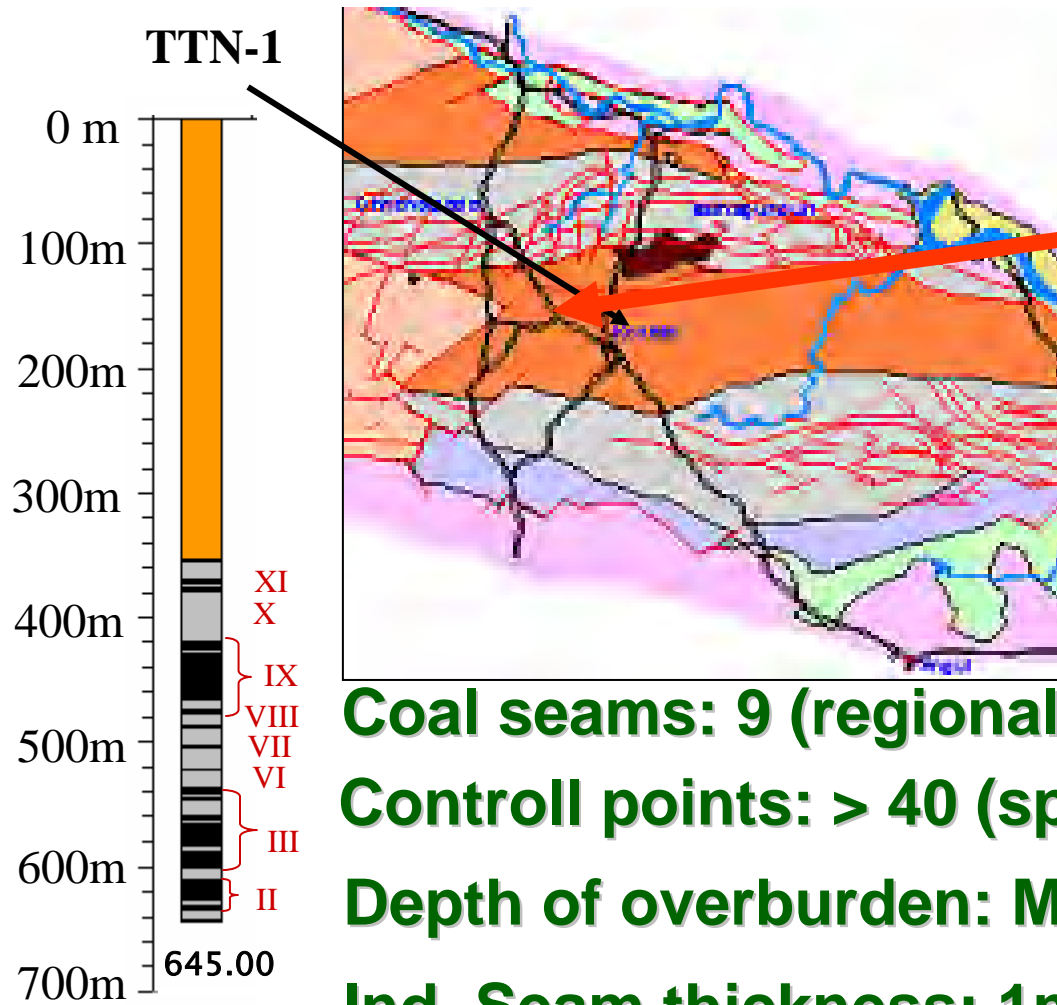
**Cumulative coal thickness
(42.27m) and development of
thicker seams(9.77m)**



T.D.1070.80

GEOLOGICAL MAP OF TALCHER C F





Coal seams: 9 (regionally persistent)

Control points: > 40 (spacing <1km – 1km apart)

Depth of overburden: Max. 350m

Ind. Seam thickness: 1m - >80m

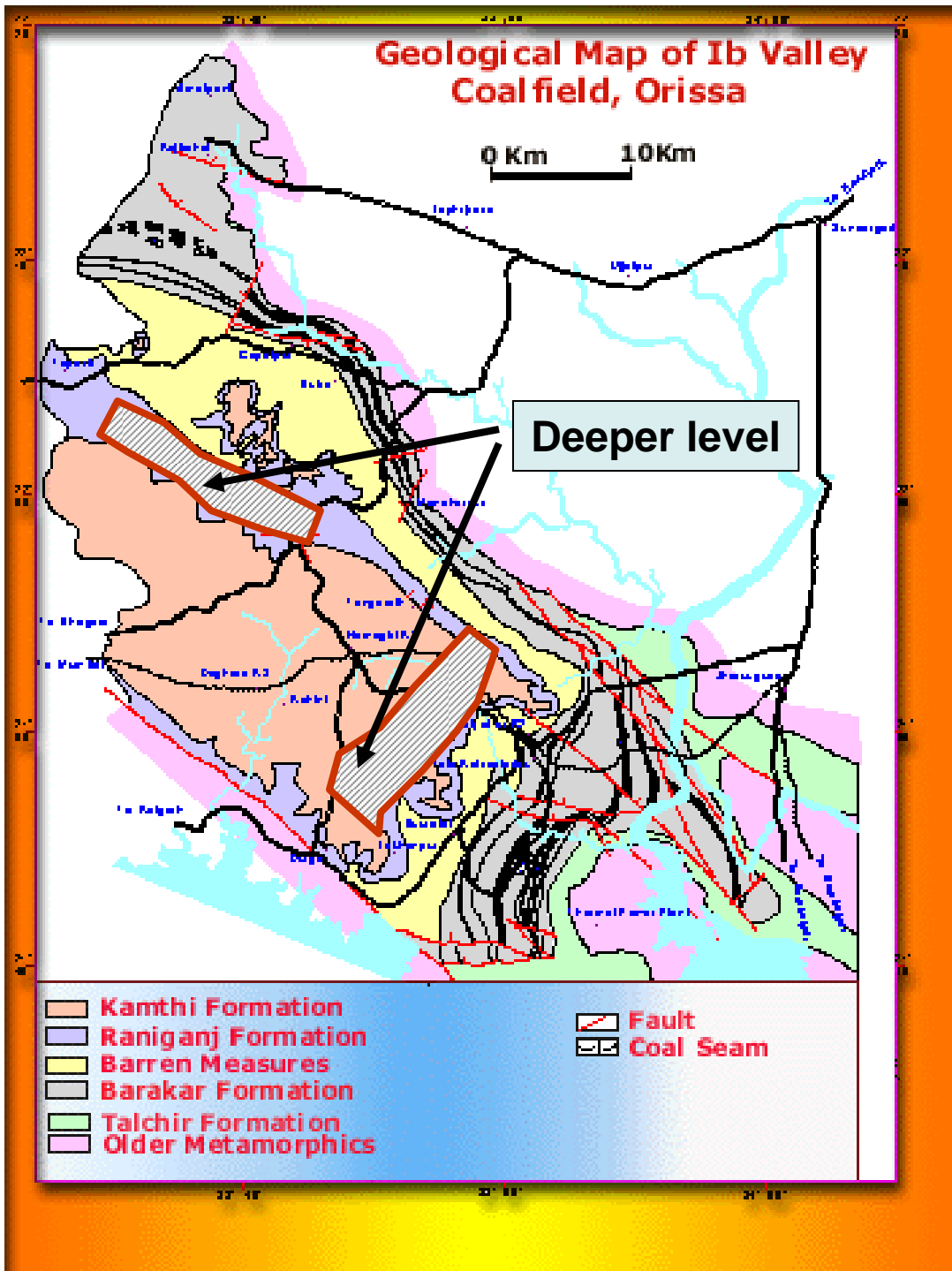
Cum. Coal thickness: 80m – 160m

Quality: M% - 4% to 7%, A% - 20% - 40%

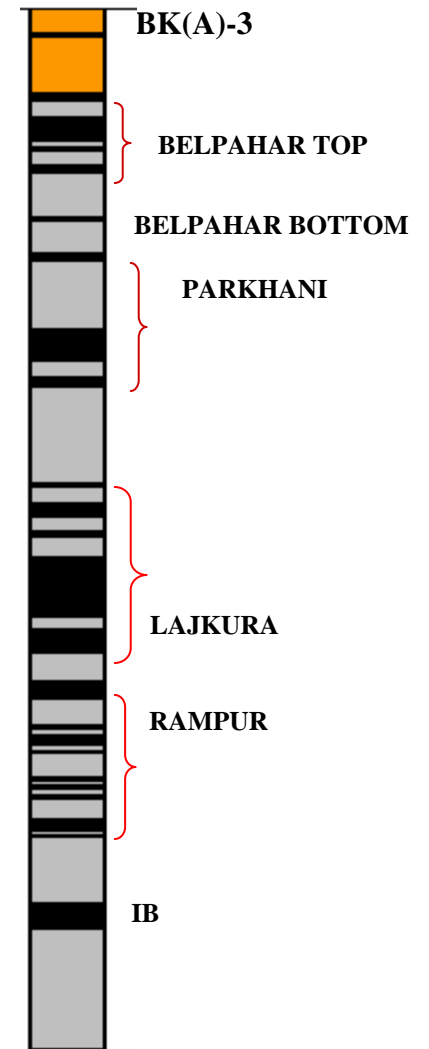
Maceral

Vitrinite (55%) Inertinite (30%) Exinite (15%)

Ro.(max): 0.45% to 0.61%



Coal seam Zones: Six
Zone thickness: 1.50m – 54m
Depth range: 31.50m – 521.50m
Grade: D - G

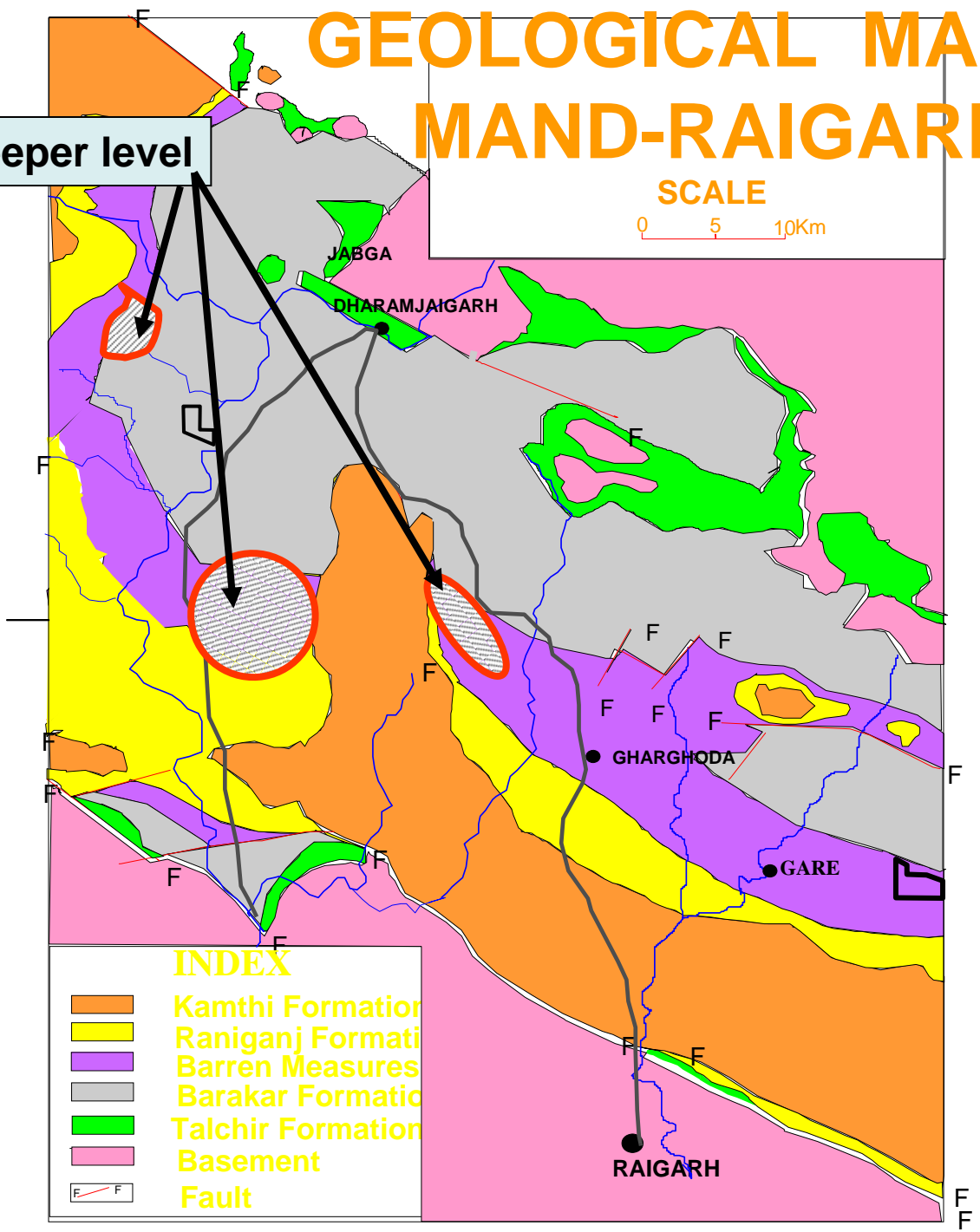


594.15m

GEOLOGICAL MAP OF MAND-RAIGARH C F

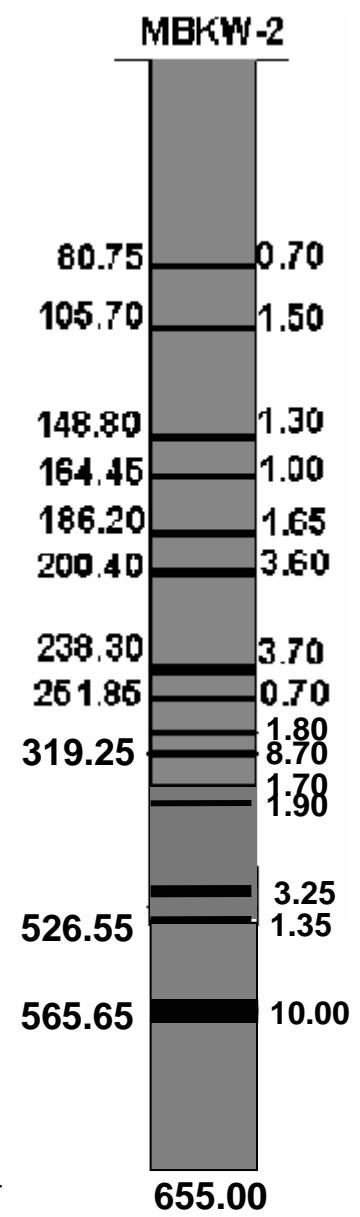
Intermediate to deeper level

SCALE
0 5 10Km



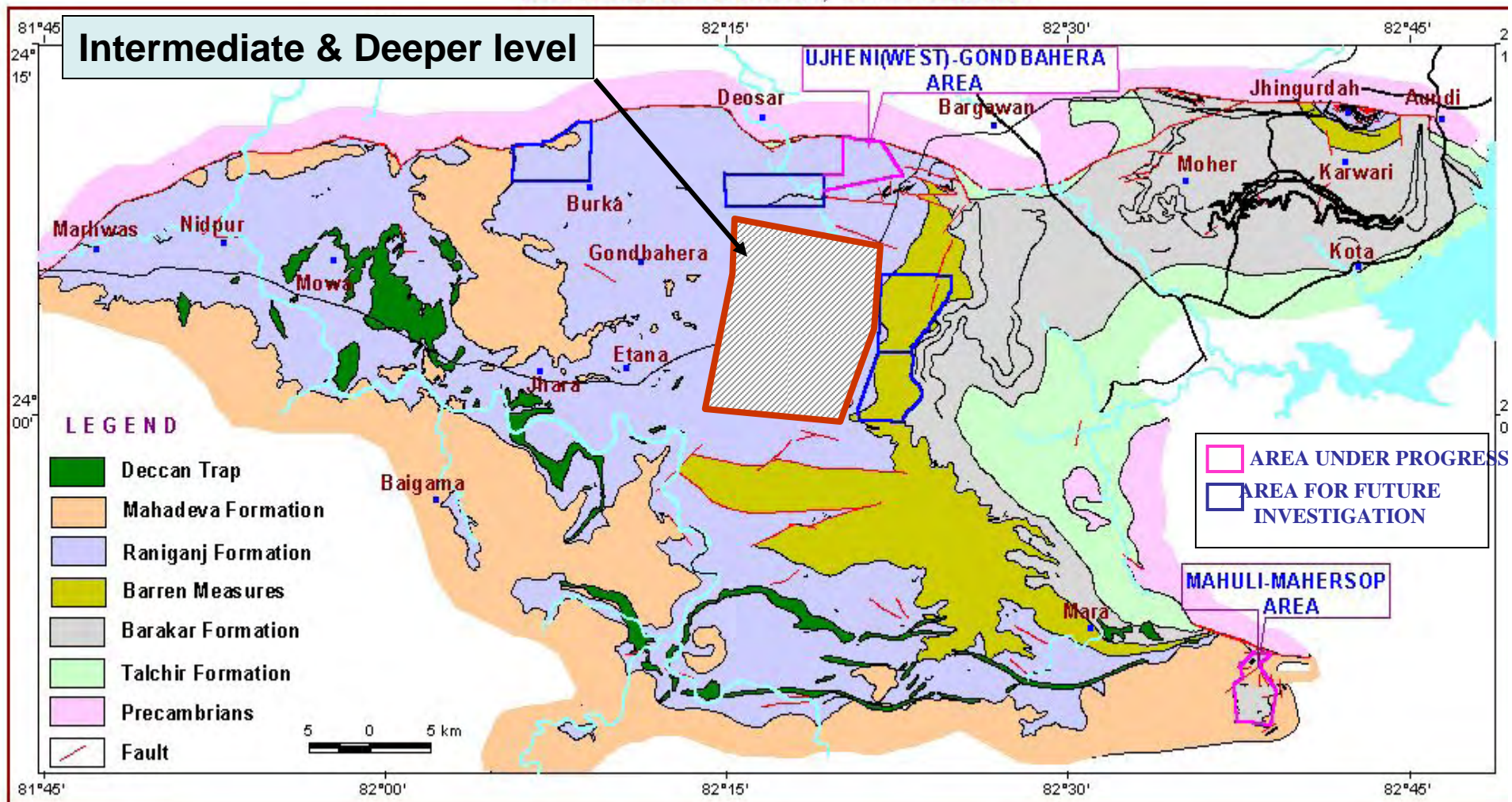
INDEX

	Kamthi Formation
	Raniganj Formati
	Barren Measures
	Barakar Formatic
	Talchir Formation
	Basement
	Fault



GEOLOGICAL MAP OF SINGRAULI COALFIELD

SIDHI DISTRICT, MADHYA PRADESH & SONBHADRA DISTRICT, UTTAR PRADESH
AND SURGUJA DISTRICT, CHHATTISGARH



SINGRAULI

Coal seams: 7- 8

Controll points: > - 30 (spacing >1km apart)

Depth of overburden: Raniganj: >150m

Barren Measure: 250-300m

Ind. Seam thickness: <1m – 18m

Cum. coal thickness: 25m –30m

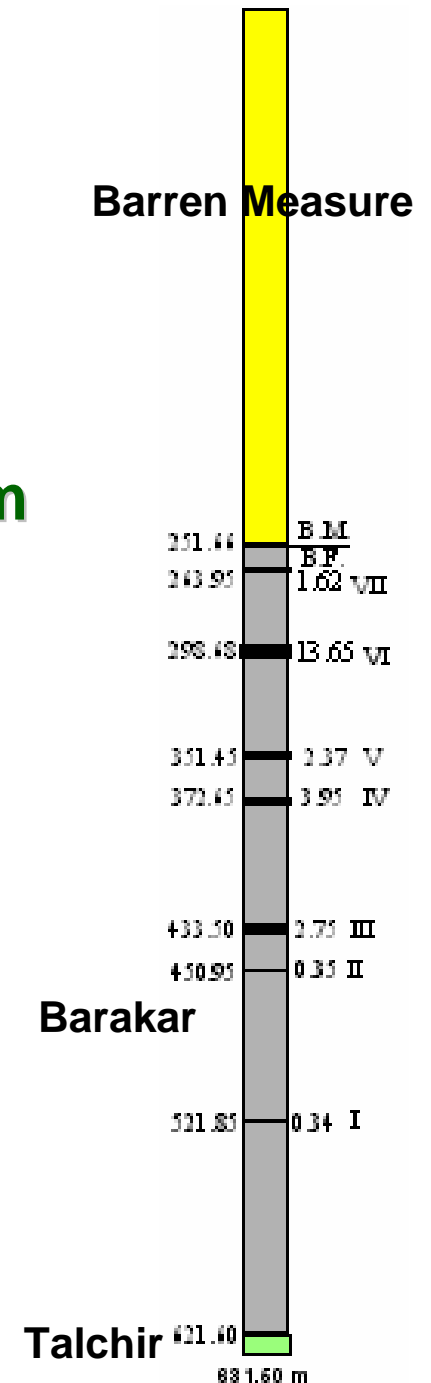
Quality: M% : 4 -10% A% : 10.3% - 45%

Maceral Vitrinite (45%- 78%)

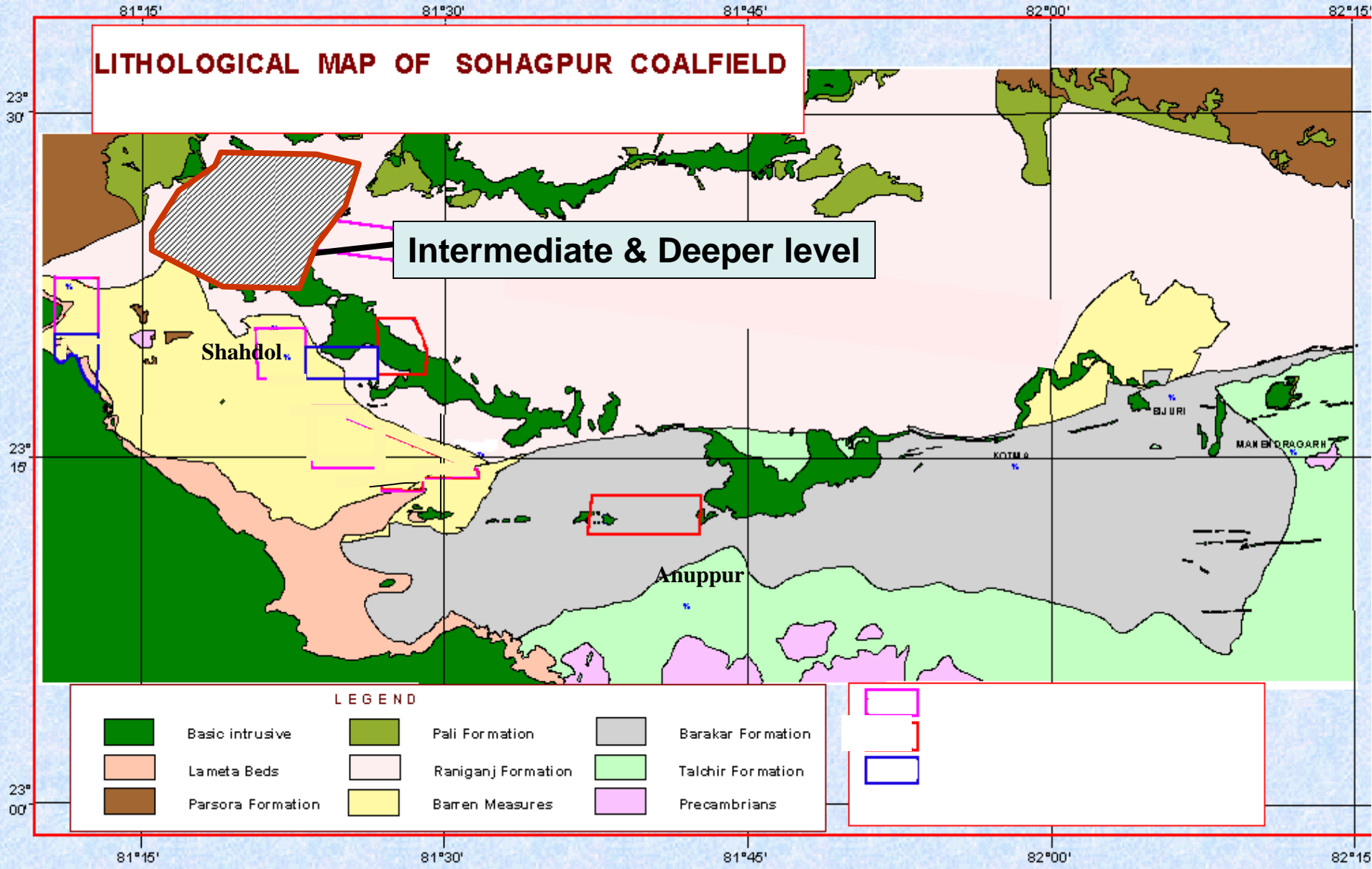
Exinite (7%- 8%)

Inertinite (8% - 45%)

Ro.(max): 0.4% to 0.6%



LITHOLOGICAL MAP OF SOHAGPUR COALFIELD



GEOLOGICAL MAP OF RAJMahal - BIRBHUM COALFIELDS

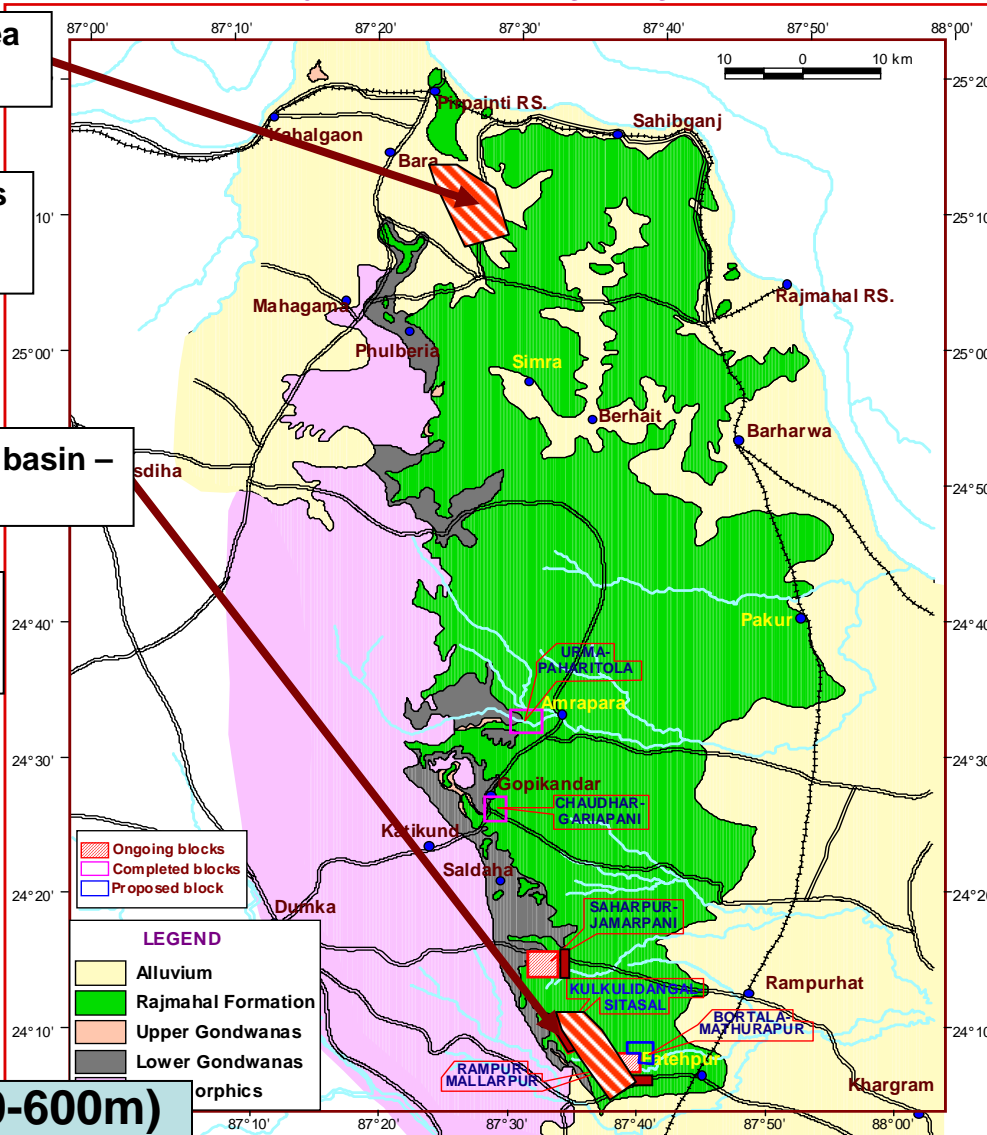
GEOLOGICAL MAP OF RAJMahal AND BIRBHUM COALFIELDS
JHARKHAND AND WEST BENGAL

Dighi-Dharampur area
(Northern Extn. Hura)

Total 10-15 seams
7 – 8 coal seams
of 6 – 15m thick

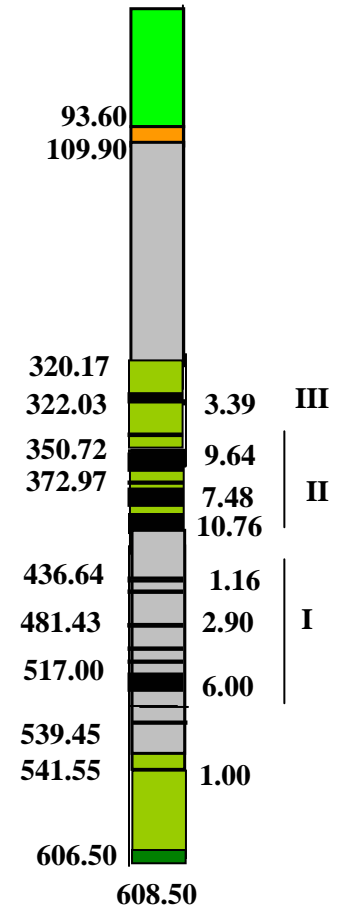
Brahmani-Birbhum basin –
southeastern part

Total > 15 seams
2 – 4 coal seams
of 5 – 7m thick

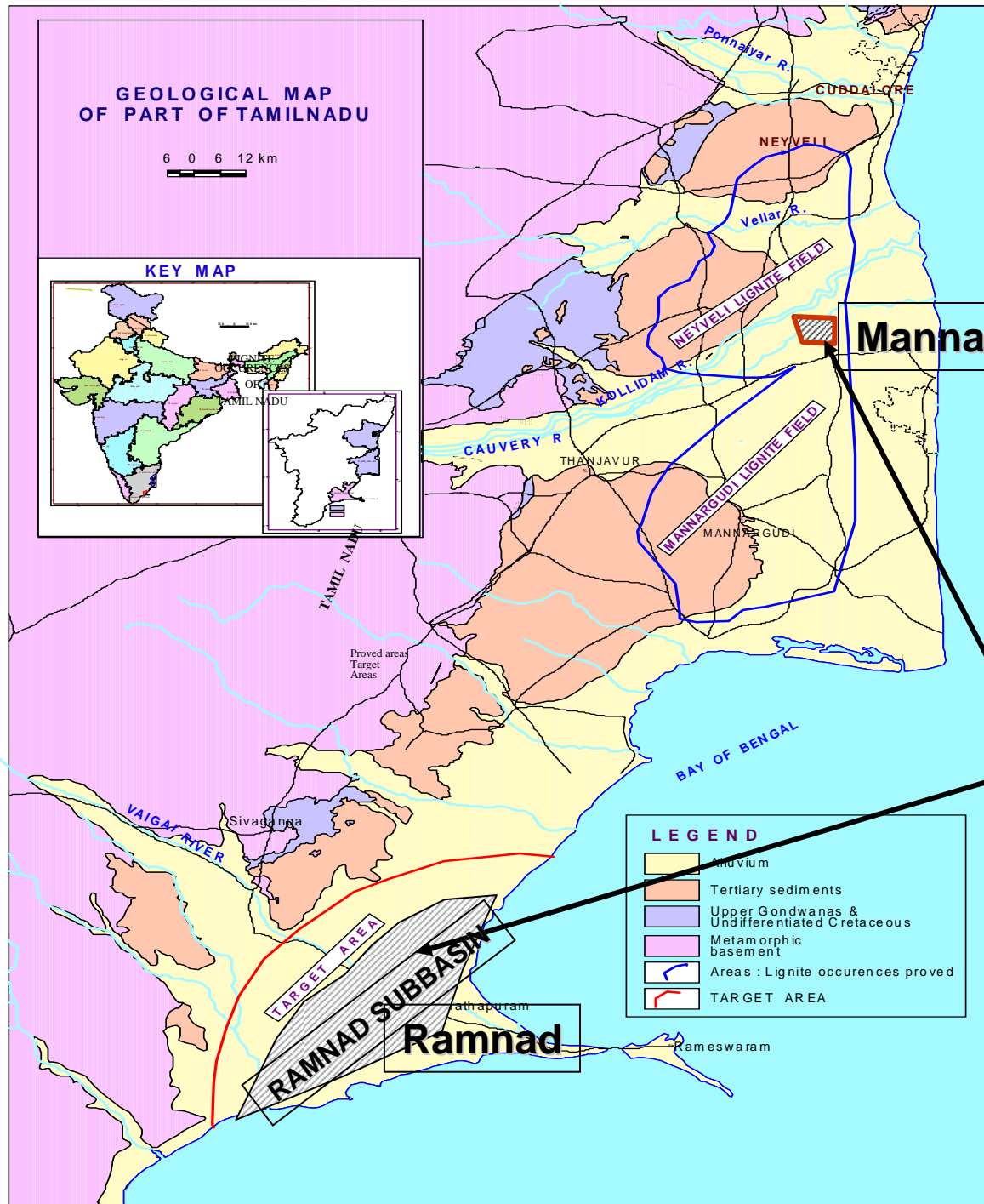


Resource (300-600m)
7B.T. (Approx)

RJKS-3A



Geological map of East Coast lignite fields, Tamil Nadu



MANNARGUDI

Lignite seams: 4-5

Control points: > - 20 (spacing >1km apart)

Depth of overburden: 250 - 350m

Ind. Seam thickness: <1m – 28m

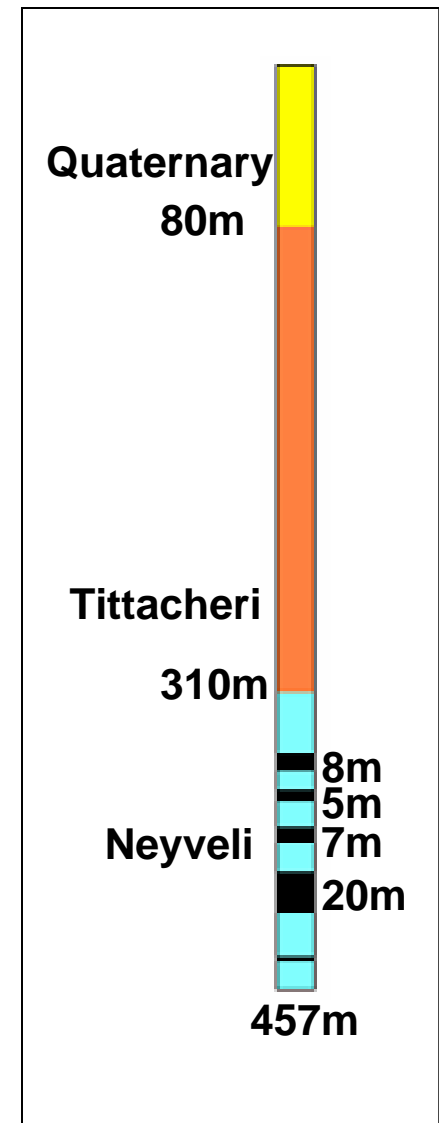
Cum. lignite thickness: 15m – 40m

Quality: M% : 30% - 40%, A% : 7% - 17%

Maceral

- Huminite (52%-86)**
- Exinite (0.9%-5.6%)**
- Inertinite (1.2%-8.7%)**

Ro.(max): 0.3% to 0.5%



RAMNAD

Lignite seams: 1 - 4

Control points: > - 17 (spacing >1km apart)

Depth of overburden: 300 - 350m

Ind. Seam thickness: <1m – 12m

Cum. lignite thickness: 6m – 18m

Quality: M% : 35% - 45%, A% : 5% - 18%

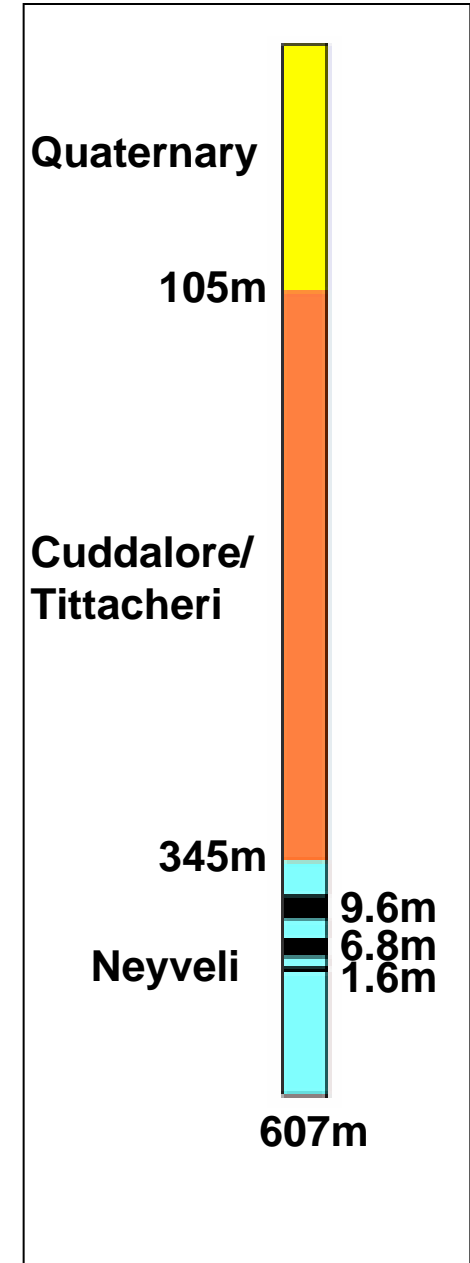
Maceral

Huminite (48%-80)

Exinite (0.9%-5.6%)

Inertinite (3% - 9%)

Ro.(max): 0.3% to 0.5%



The background features three overlapping teal diamonds. The diamonds are arranged from top-left to bottom-right, with each subsequent diamond shifted further down and to the right. The text 'Thank you' is centered over the rightmost diamond.

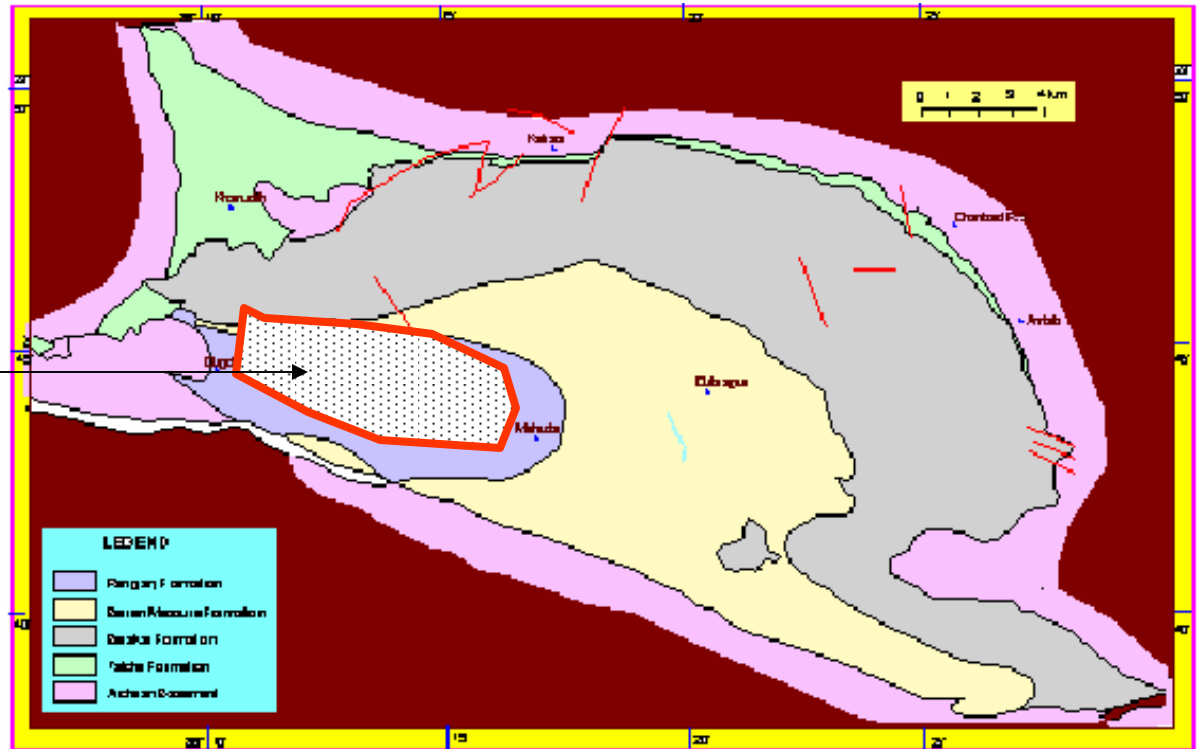
Thank you

The background features three overlapping teal diamonds. The diamonds are arranged from top-left to bottom-right, with each subsequent diamond shifted further down and to the right. The text 'Thank you' is centered over the rightmost diamond.

Thank you

JHARIA COALFIELD

Deeper level



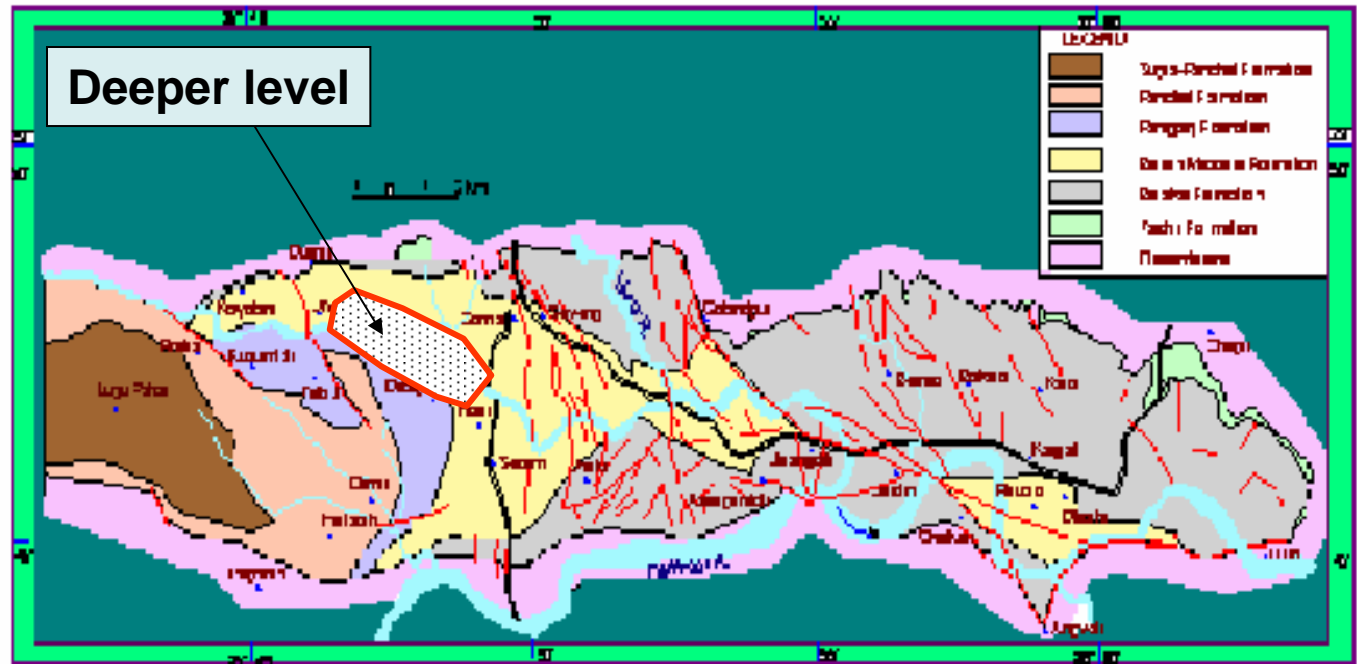
Salient features

FORMATION	THICKNESS	COAL SEAMS	
		No	Thickness
Intrusives			
Raniganj	725m	22	(0.1m-4.7m)
Barren Measures	850m		
Barakar	1130m	46	(0.3m-33.0m)
Talchir	225m		
Basement	--		

COAL RESOURCE

0-600m -- 14.2 bt
600m-1200m -- 5.2 bt
0 – 1200m – 19.4 bt

EAST BOKARO COALFIELD



Salient features

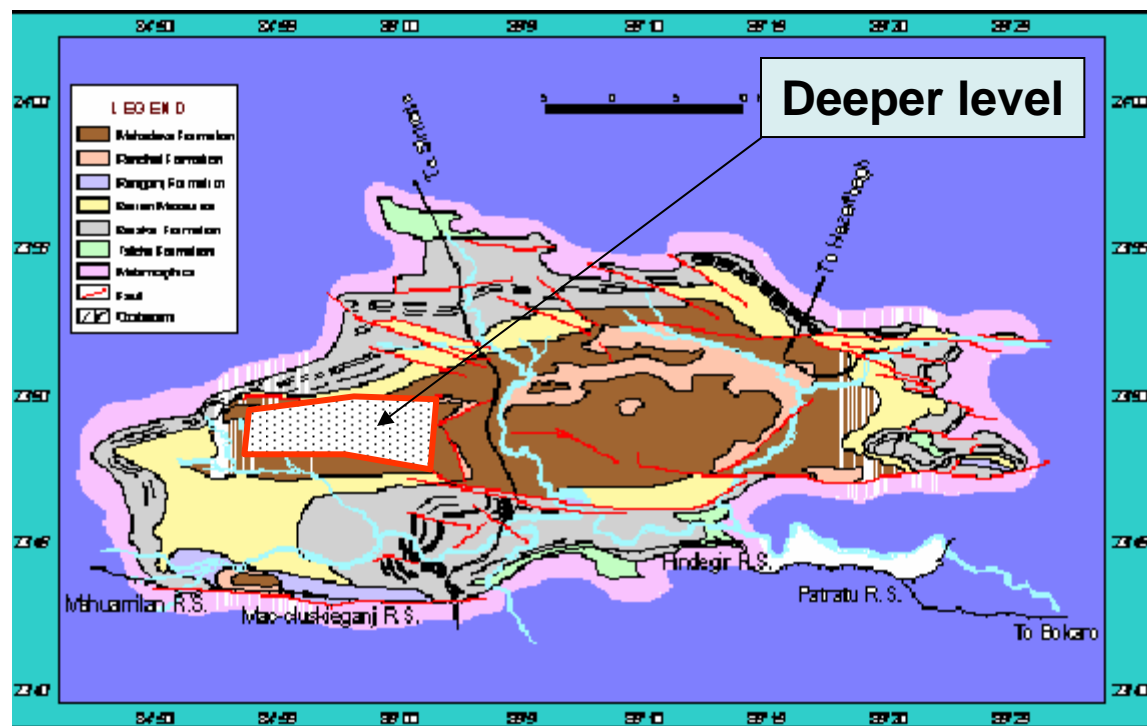
FORMATION	THICKNESS	COAL SEAMS	
		No	Thickness
Mahadeva	500m		
Panchet	600m		
Raniganj	600m	7	(0.4m-3.0m)
Barren Measures	500m		
Barakar	1000m	26	(0.4m-63.9m)
Talchir	80m		
Basement	--		

COAL RESOURCE

0-300m -- 3.2 bt
300m-600m -- 1.5 bt
600m-1200m -- 2.3 bt
0 – 1200m -- 7.0 bt

NORTH KARANPURA COALFIELD

Salient features



FORMATION	THICKNESS	COAL SEAMS
Mahadeva	165m	No Thickness
Panchet	225m	
Raniganj	400m	thin bands
Barren Measure	385m	
Barakar	500m	5 (0.5m-35.2m)
Karharbari	200m	1 (0.5m-10.5m)
Talchir	180m	
Basement	--	

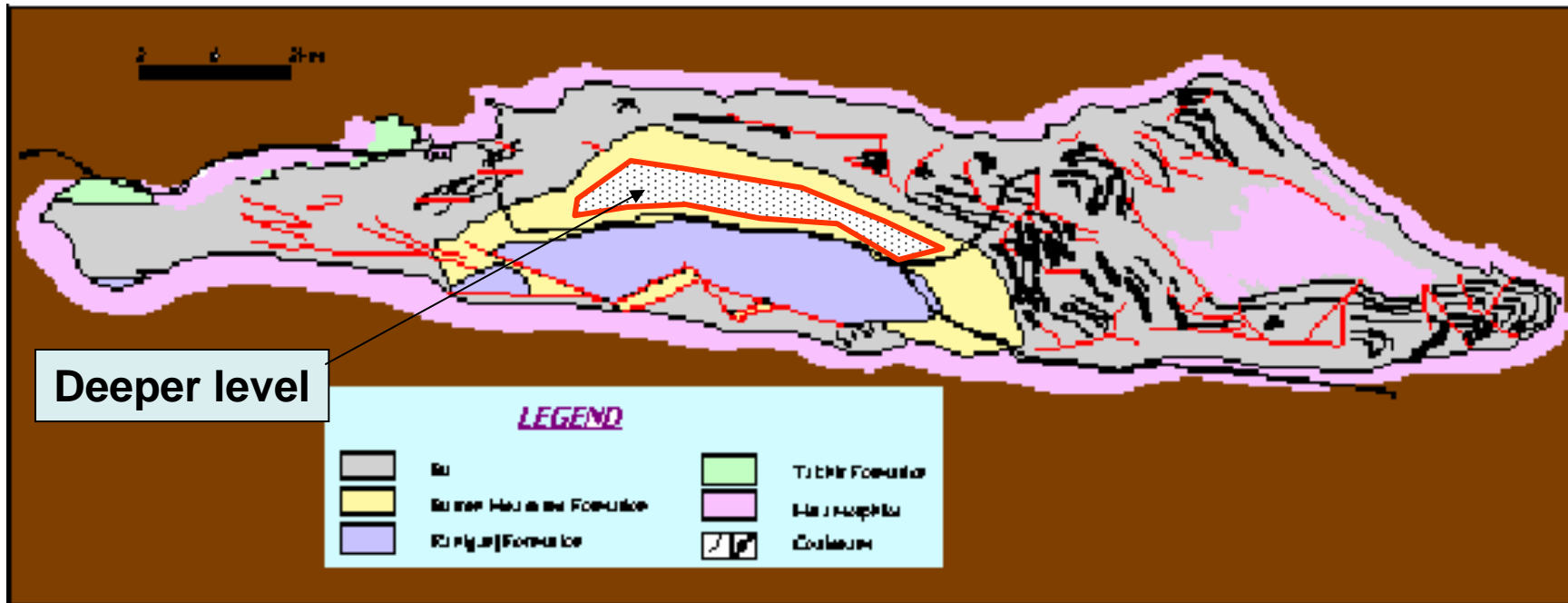
COAL RESOURCE

0-300m -- 10.3 bt

300m-600m -- 4.3 bt

0 – 1200m – 14.6 bt

SOUTH KARANPURA COALFIELD



Salient

features

	THICKNESS	COAL SEAMS	
		No	Thickness
Raniganj	360m	7	(0.8m-3.3m)
Barren Measures	385m		
Barakar	1050m	42	(0.5m-54.2m)
Talchir	180m		
Basement	--		

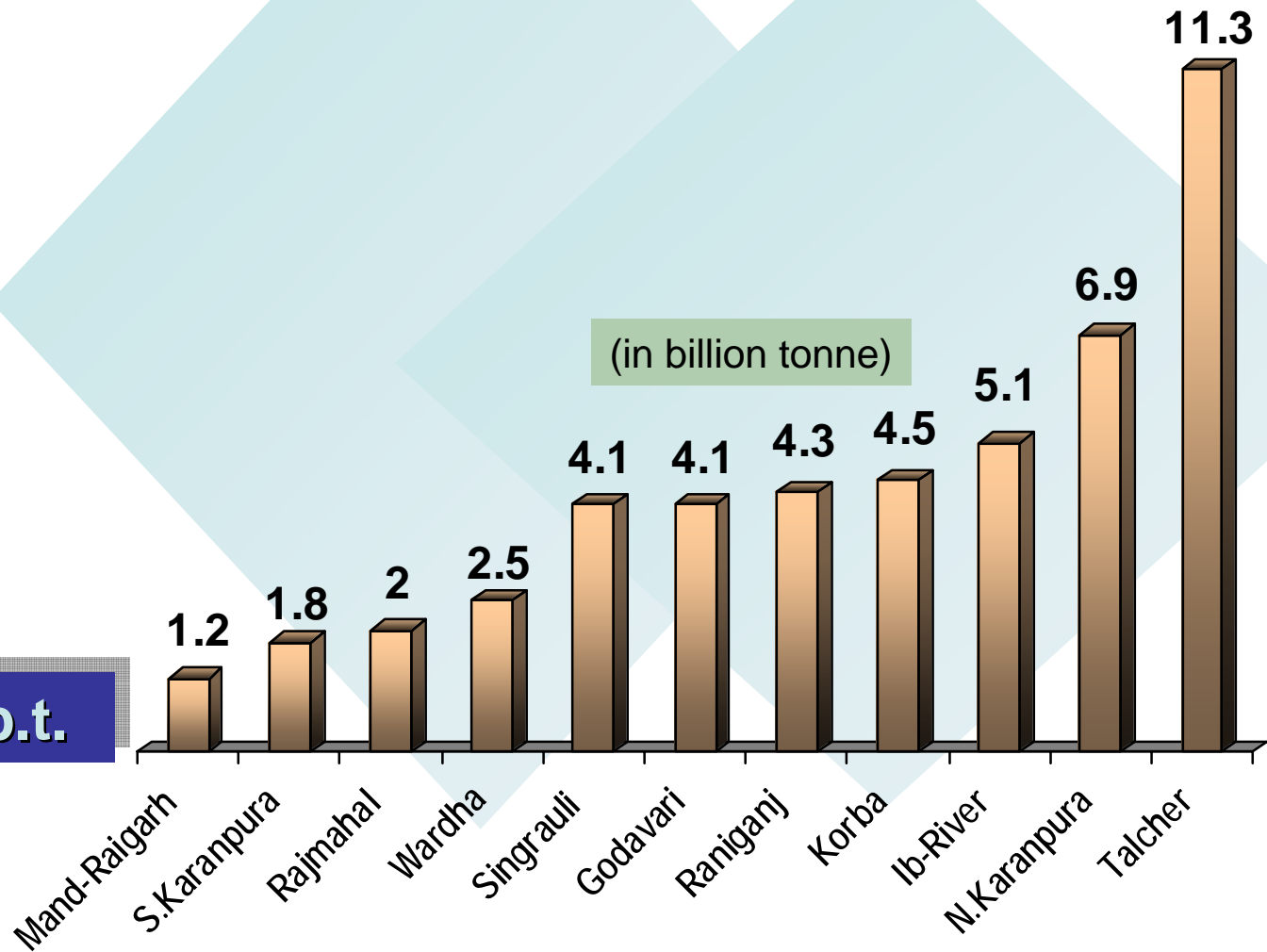
COAL RESOURCE

0-300m -- 3.3 bt
300m-600m -- 1.8 bt
600m-1200m -- 0.9 bt
0 – 1200m – 6.0 bt

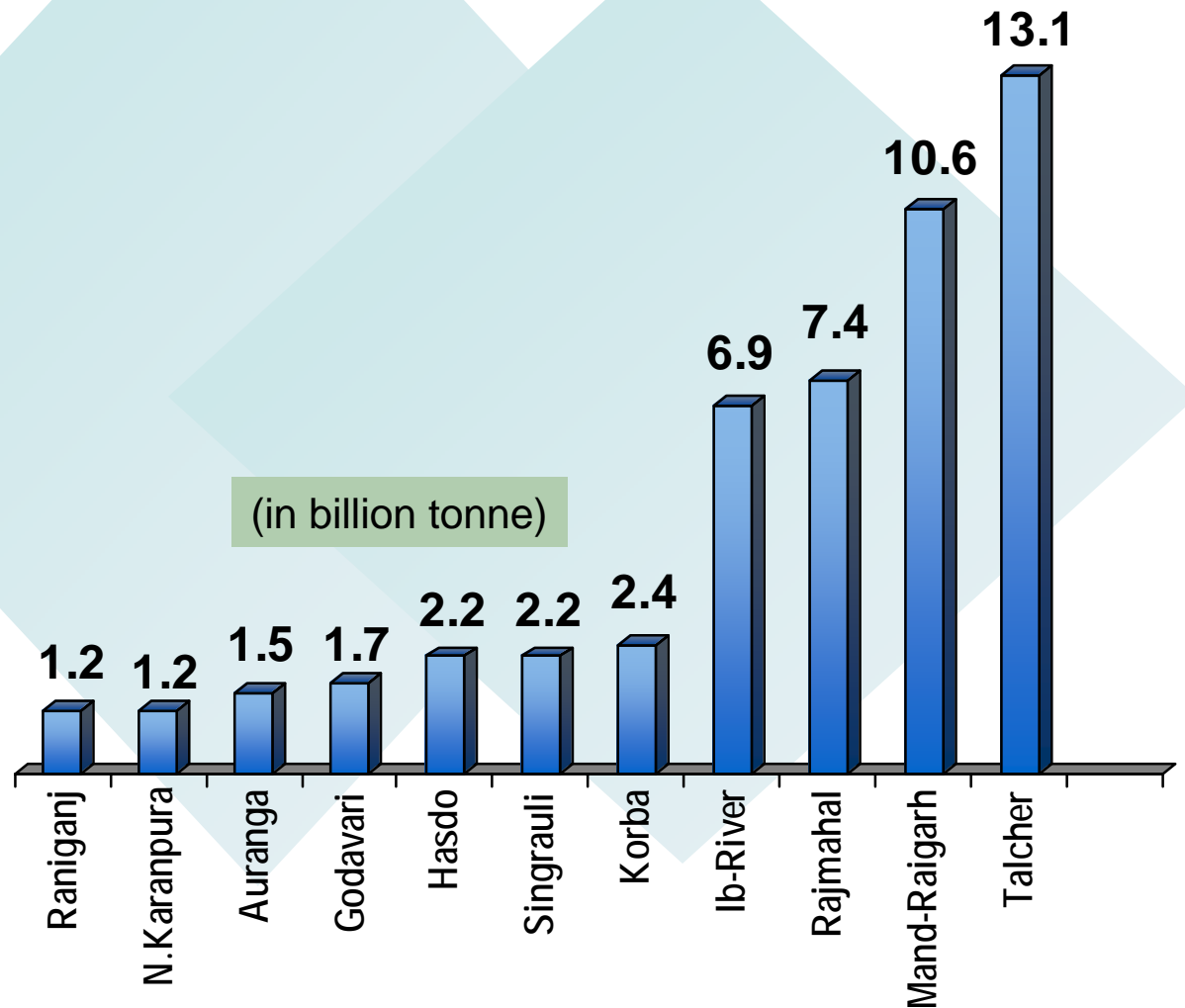
Distribution of substantial resource under **‘Proved’ category** within **0-300m** depth level

(in billion tonne)

Resource >1 b.t.

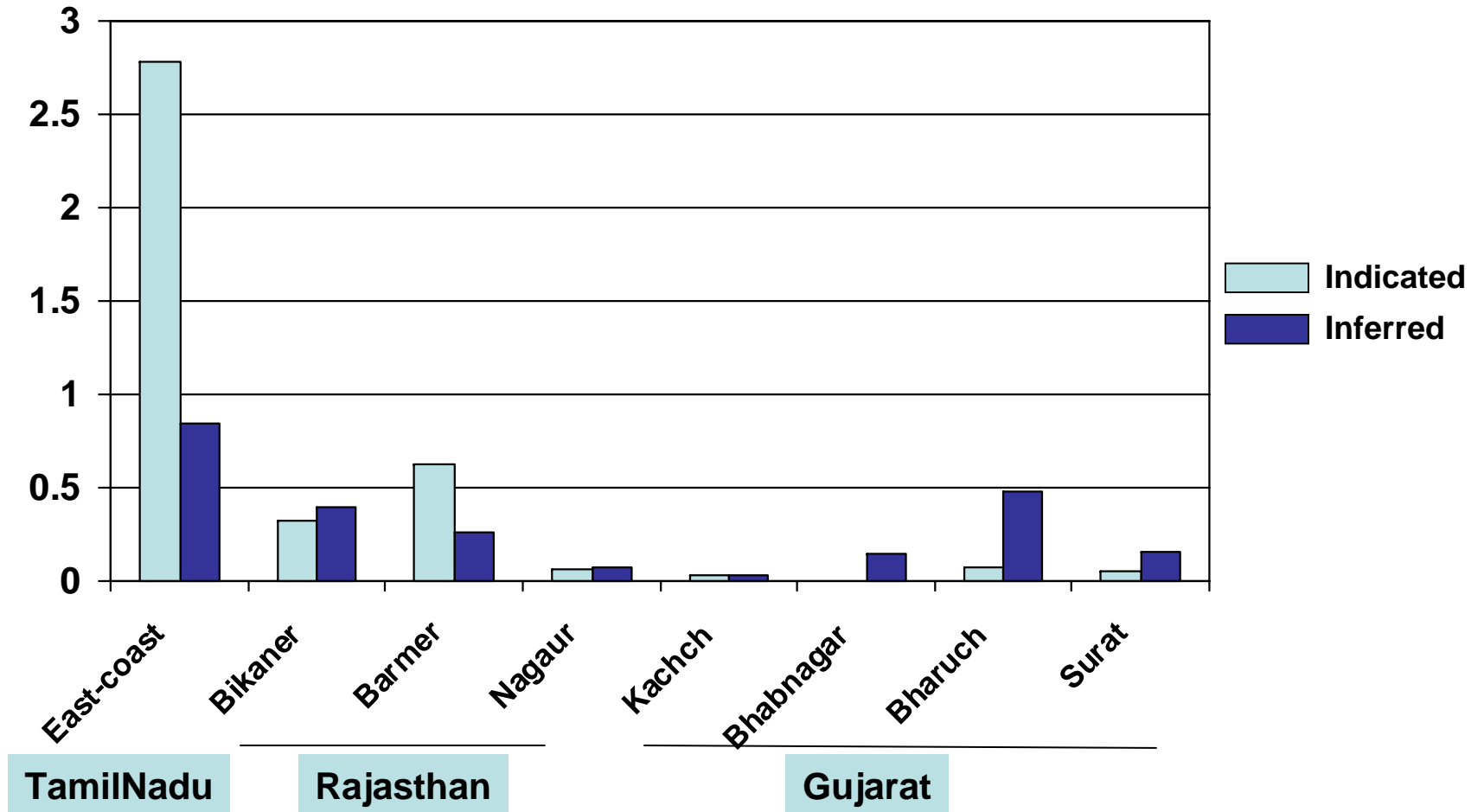


Distribution of substantial resource under 'Indicated' category within 0-300m depth level



Resource >1 b.t.

Status of shallow level (<150m) resource needs to be upgraded in different lignite basins



STUDIES CARRIED OUT BY GSI

PETROGRAPHICAL CHARACTER OF GONDWANA COAL IN DIFFERENT COALFIELDS

